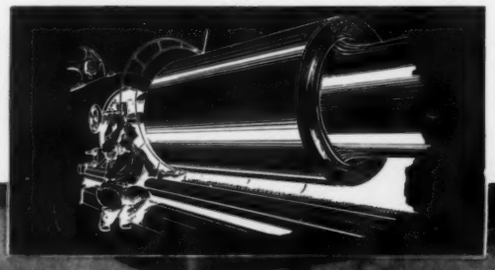
Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

OCTOBER, 1959

PLATE MILLS *designed and built by*

MESTA

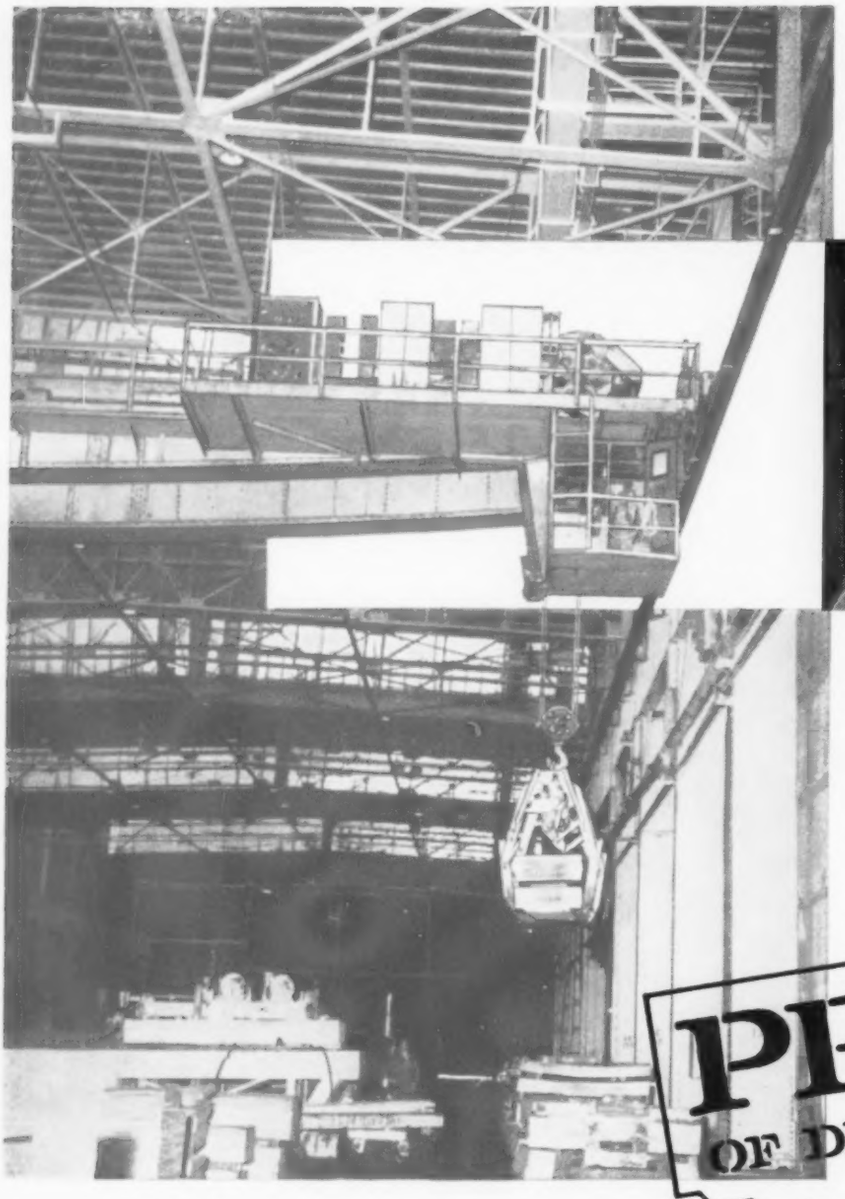


160" Four-High Reversing Plate Mill

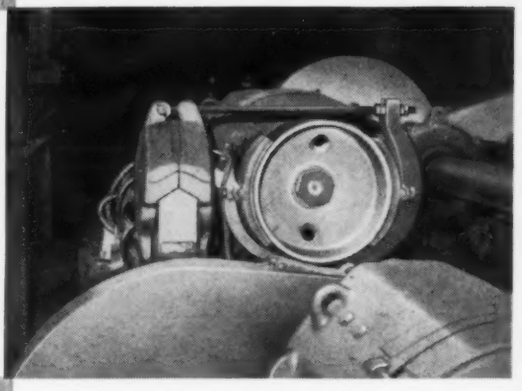
MESTA *Machine Company*

Pittsburgh, Penna.

Cutler-Hammer 505 Mill Brakes set new performance records at Inland Steel



Cold Strip Finishing
Mill Crane 35B



This 16" Cutler-Hammer 505 Mill Brake was installed in 1954, first to be used by Inland Steel. Service records show nine months passed before the brake required an adjustment of the shoe clearance. To date the original linings and wheel are still in service.

PROOF OF DEPENDABILITY

Here's positive *proof of dependability* . . . proof that Cutler-Hammer 505 Mill Brakes work better and last far longer even under the most severe operating conditions. Why take chances with costly production interruptions caused by frequent mill brake service requirements? Install dependable, service-proven Cutler-Hammer 505 Mill Brakes and be sure. For complete information, write today for Bulletin 505-U232. Cutler-Hammer Inc., Milwaukee 1, Wisconsin.

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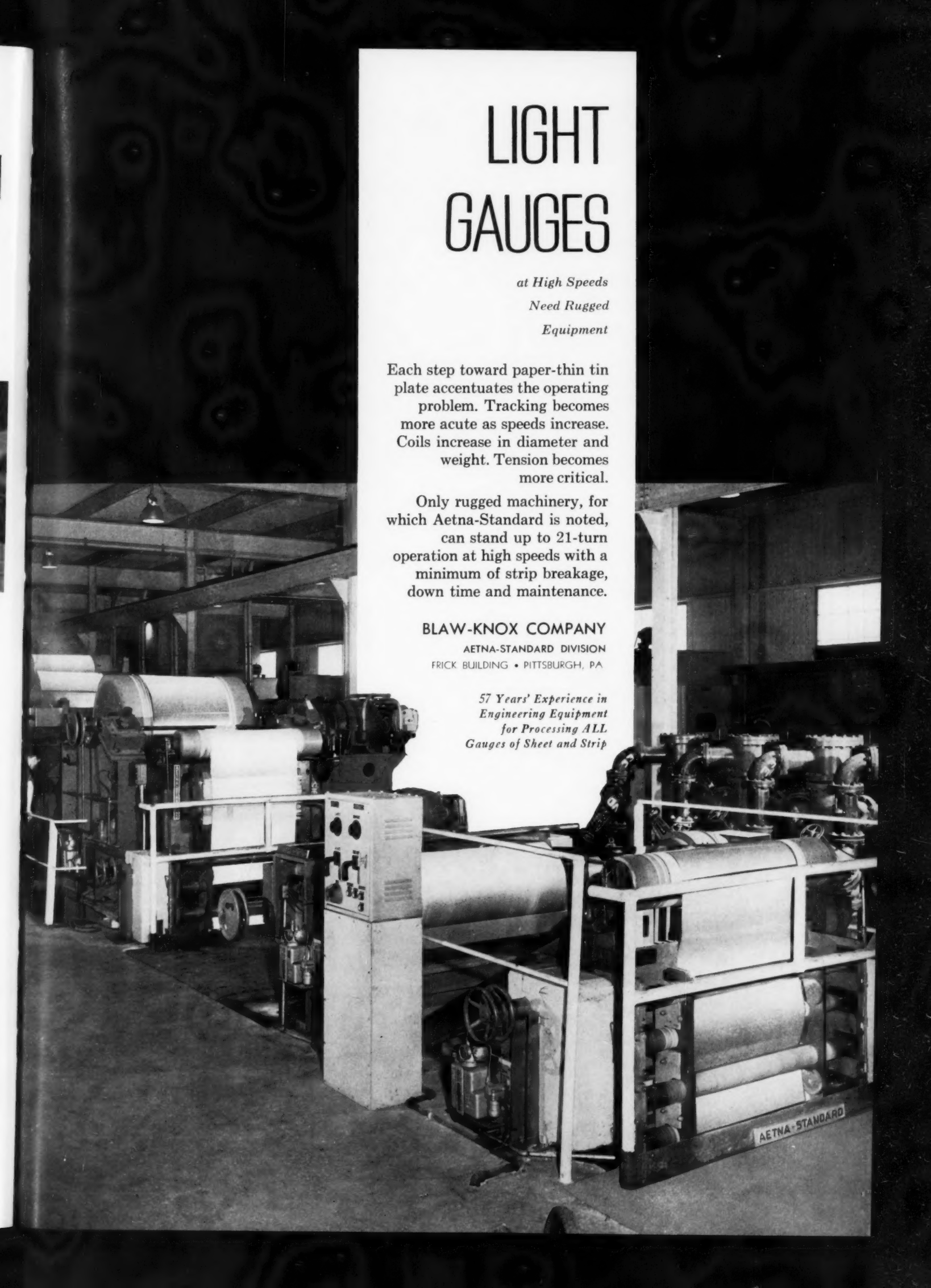

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FRICK BUILDING • PITTSBURGH, PA

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Iron and Steel ENGINEER

Volume XXXVI • Number XX **OCTOBER, 1959**

75 Modern Design Of Slab Reheating Furnaces
By H. C. Henschen

83 Modern Regenerative Soaking Pits
by Henry S. Hall

93 Development Of A New Horizontal-Flow, Plate-Type Precipitator For Blast Furnace Gas Cleaning
By Bengt R. Berg

102 From Ingot To Ingot In Fifteen Days—Replacing a 27-in. Universal Slabbing Mill with a 38 x 66-in. Slabbing Mill On the Same Site
by David Hugh Samson

113 Maintenance Organization And Training
by C. F. McClurg

122 Production of Di-Ammonium Phosphate
by Chelsie K. Pearson

126 Bifurcation Of Open Hearth Furnaces
by C. G. Campbell

129 Open Hearth Slag Handling
by G. R. Morgan

133 Mobile Units Reduce Plant Material Handling Costs
by Dan H. Driscoll

138 The Direct Reading Spectrograph And Its Use
by William J. Fertal and Milton E. Mador

142 Pictorial Review—AISE Annual Convention

144 AISE District Section Meeting Notices

145 Increased Production Through Electrolytic Tinning Line Modernization
by Donald H. Jenter

151 Available Translations

152 Prize Winning Papers Announced At Banquet

154 Ingenious Construction Minimizes Production Delays
by Harry Ellsberg

158 Metal-Plastic Combination Materials

163 Agglomeration Tests Begin In New Grate-Kiln Pilot Plant

167 Regulation of Blast Furnace Pressure Gives Increased Iron Production

DEPARTMENTS

11 Crops and Shorts
21 Patent Reviews
61 Foreign Digests
169 Date-line Diary
179 Industry News
195 Personnel News
233 Equipment News
251 Index to Advertisers

Published Monthly by

ASSOCIATION OF IRON AND STEEL ENGINEERS
1010 EMPIRE BUILDING PITTSBURGH 22, PENNSYLVANIA

Statements and opinions given in articles and papers appearing in "Iron and Steel Engineer" are the expressions of contributors, for which the Association of Iron and Steel Engineers assumes no responsibility.

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Indexed by Engineering Index and by Industrial Arts Index.

Single Copy Foreign Prepaid $2.00 (U. S. funds) Single Copy $1.50
Subscription price in U. S. and Canada (U. S. funds) ..... $ 7.50 per year
Subscription price in foreign countries (U. S. funds) ..... $10.00 per year

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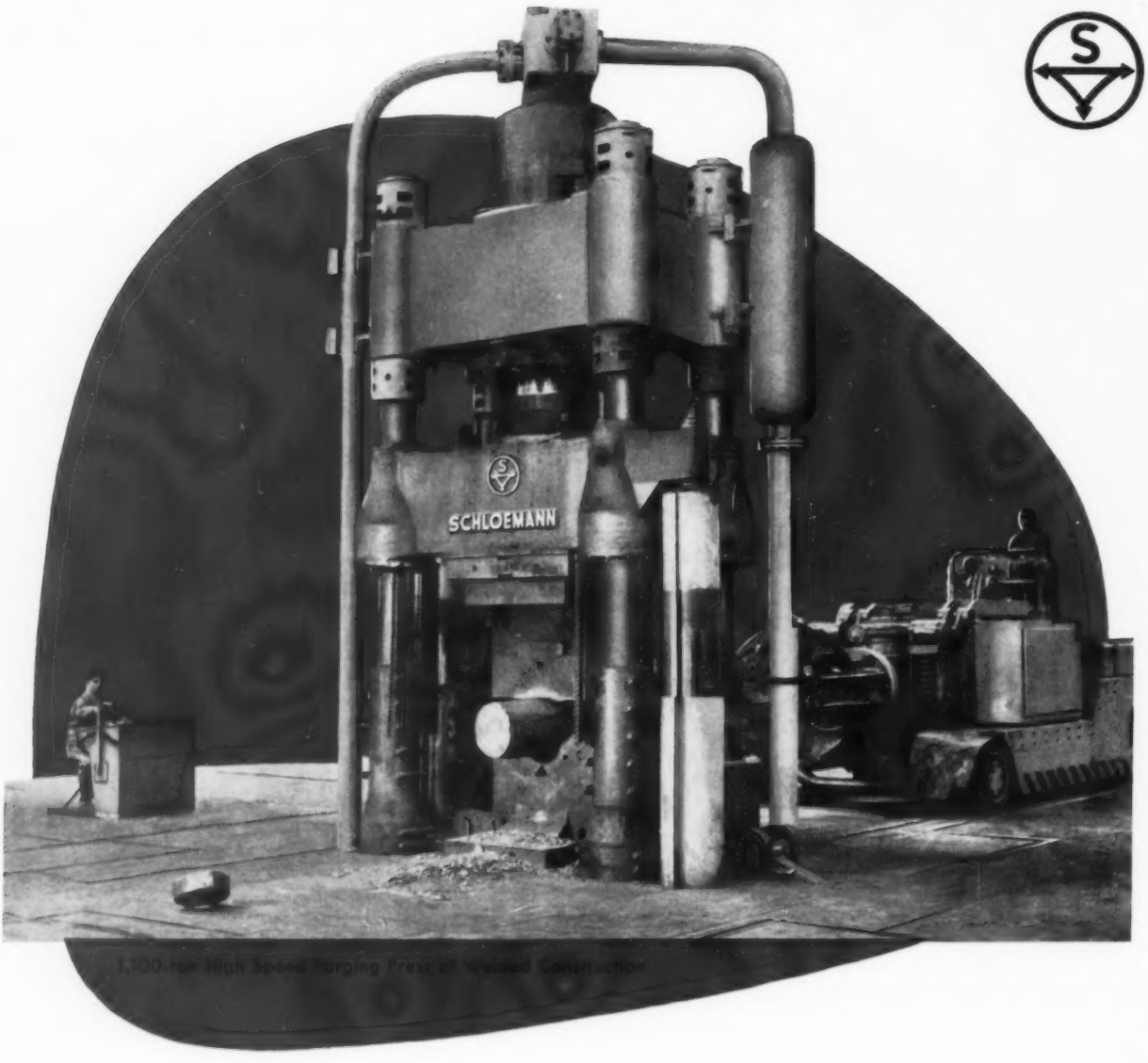

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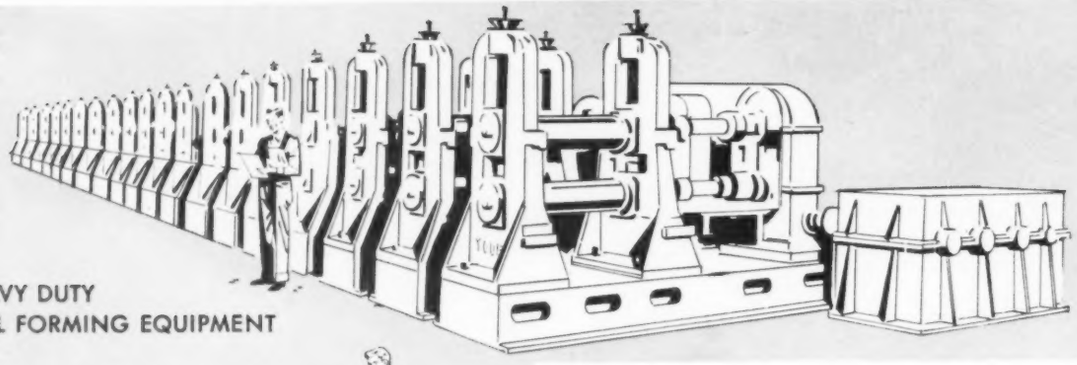
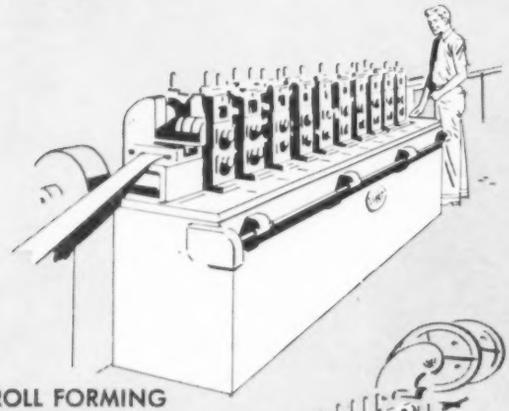
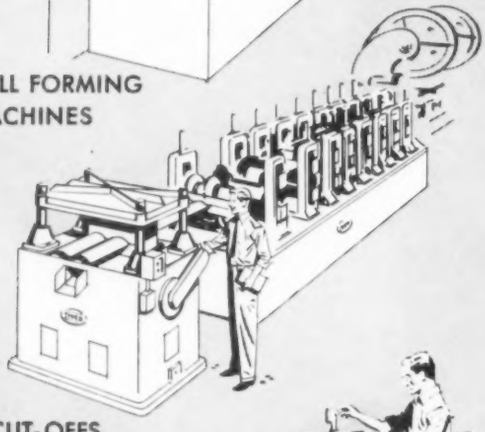


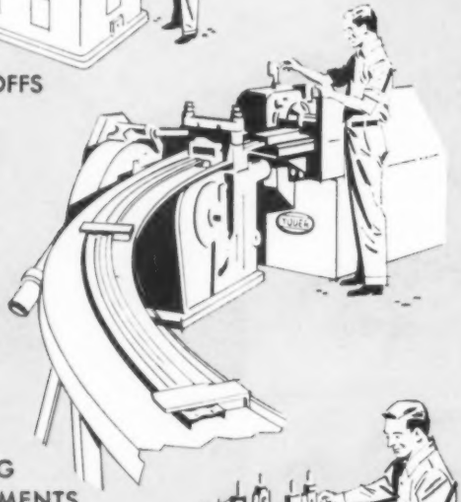
HEAVY DUTY
ROLL FORMING EQUIPMENT



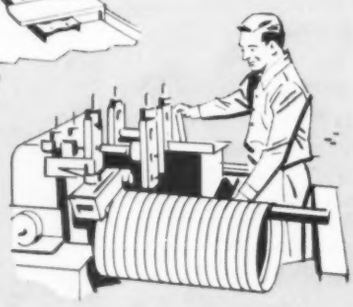
ROLL FORMING
MACHINES



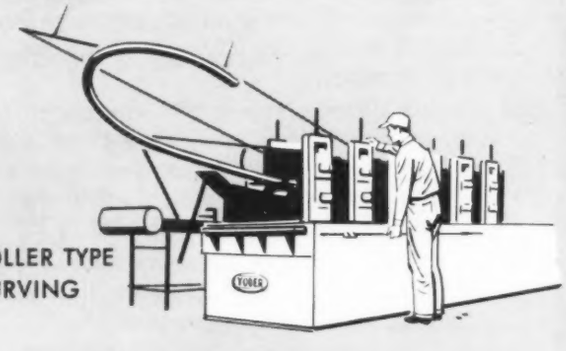
CUT-OFFS



CURVING
ATTACHMENTS



COILING
EQUIPMENT



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High speed, YODER Cold Roll-Forming machines are the most economical method for mass producing structural or ornamental shapes. One machine with one operator can form up to 40,000 feet of shapes per day. Even on a part-time basis, a YODER Cold Roll-Forming machine can prove to be a profitable investment.

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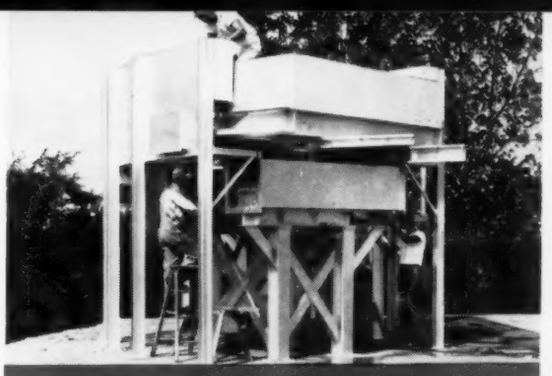
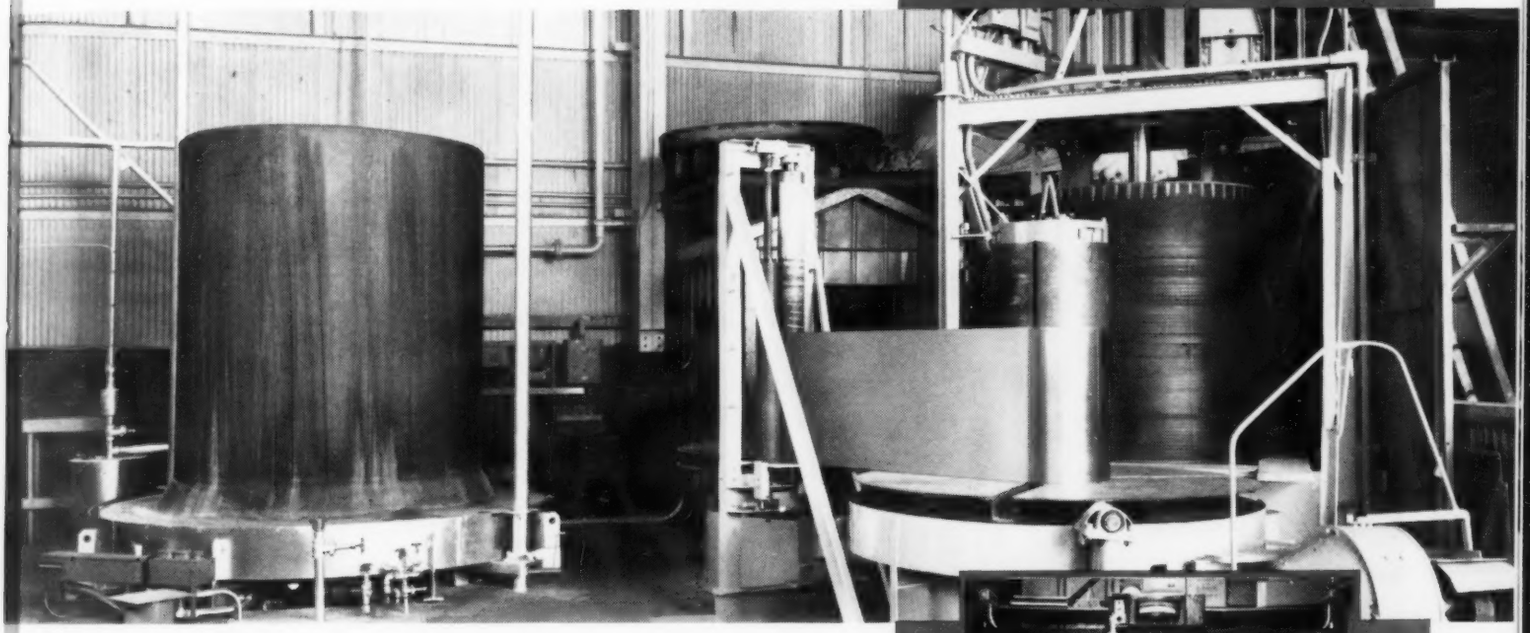
RESEARCH IN DEPTH...

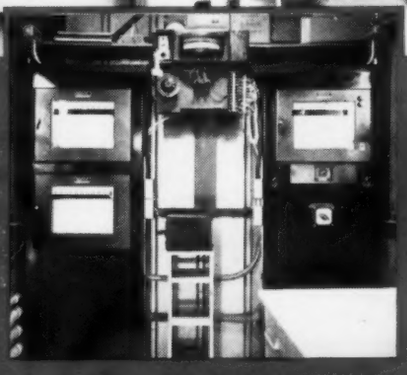
keeps Lee Wilson first in annealing



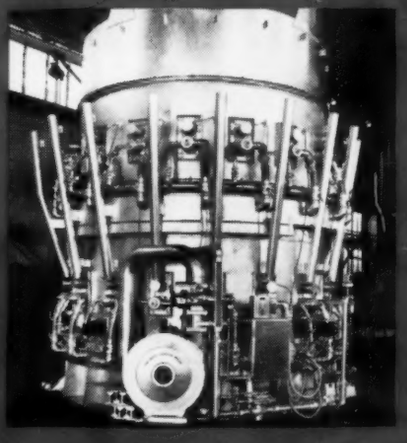
Full-scale wooden mock-up of two sections of the eight-zone new Lee Wilson Rotary Opened Coil Annealing Furnace enables Lee Wilson engineers to study design and construction details.



Typical scene at Lee Wilson Research Center shows test coil (on the right) being tight-wound for temper rolling after annealing; on the left, an inner cover over a test charge being purged.



Extensive temperature and recording installation to make permanent records of every test.



Full-scale production furnace for annealing opened coils.

Research in depth keeps Lee Wilson the first name in advanced annealing techniques and equipment. Here is shown a part of the full-scale experimental equipment built by Lee Wilson engineers to thoroughly test the new *opened coil method* of annealing under actual operating conditions. Such extensive research facilities aid in the design and construction of better equipment and enable steelmakers to test their products in this new equipment. The world's leading steelmakers have sent silicon, tin plate and carbon coils to the Lee Wilson Research Center for thorough annealing tests. Full-size coils of many different analyses have been annealed in this opened coil pilot plant with exceptional results.

It is this kind of "beyond-the-drawing board" effort that is the secret behind the advanced design and dependability of Lee Wilson annealing equipment. If you want concrete evidence of what the world's most highly developed annealing techniques can do for your product, why not arrange now for a coil test.

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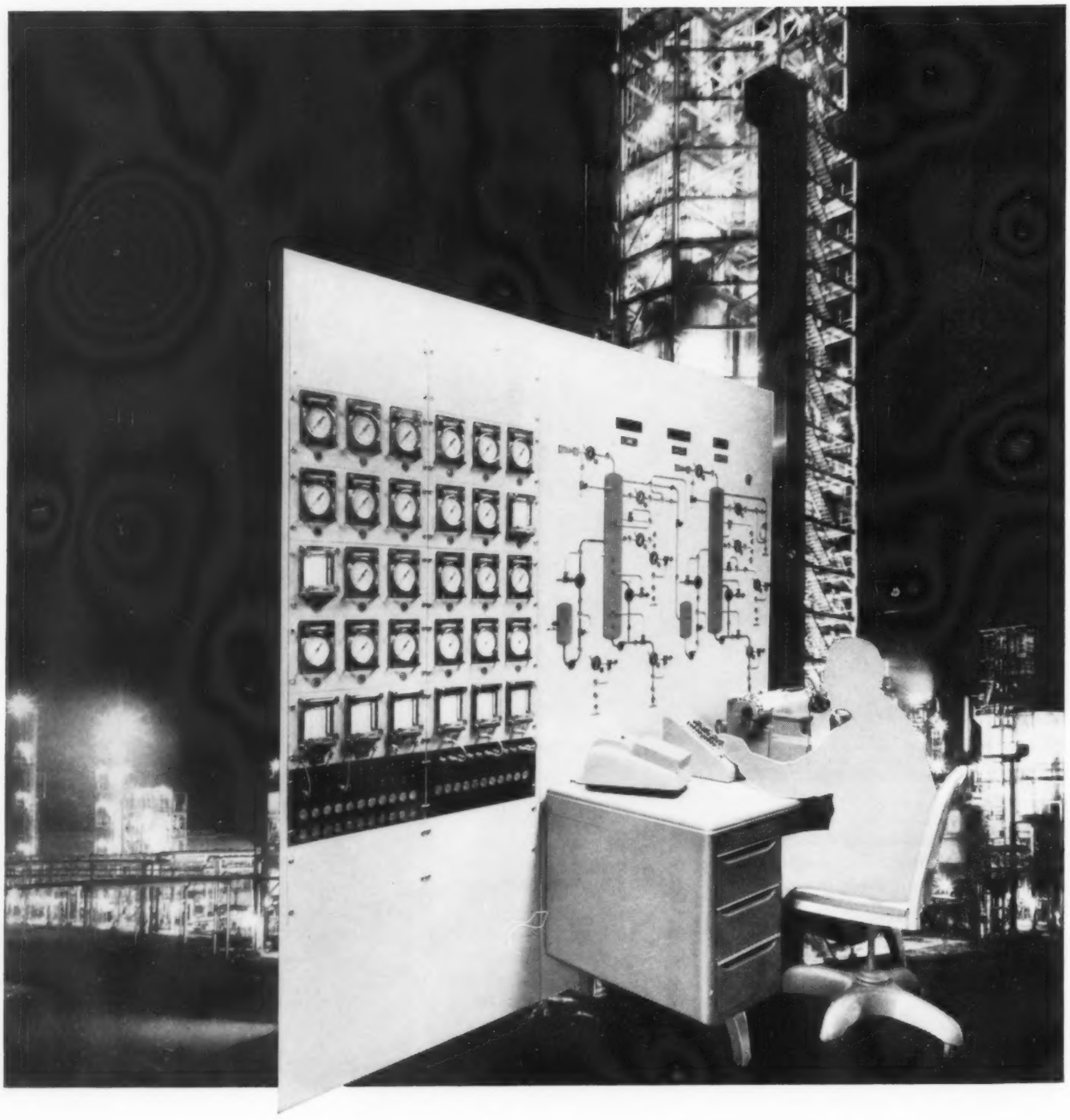
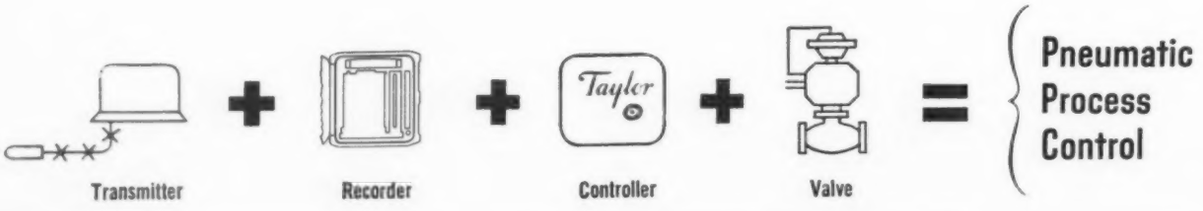


PNEUMATIC SYSTEMS



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Taylor Trans-Scan-Log Control System proved exceptionally dependable in three years of field service!*

IN the Chemical and Petroleum industries, Taylor Trans-Scan-Log systems have won an enviable reputation for reliability since their introduction over three years ago. They are in use on a variety of applications, controlling, scanning and logging up to 550 points of measurement.

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Normal graphic panel space is cut by 40% because no instrument cut-outs are required on the flow diagram. The flow chart can be readily modified to match any process changes. With plug-in receivers and controllers mounted on a separate section of the panel, maximum process flexibility is achieved.

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Meanwhile write for **Bulletin 98268.** Taylor Instrument Companies, Rochester, N. Y. and Toronto, Ontario.

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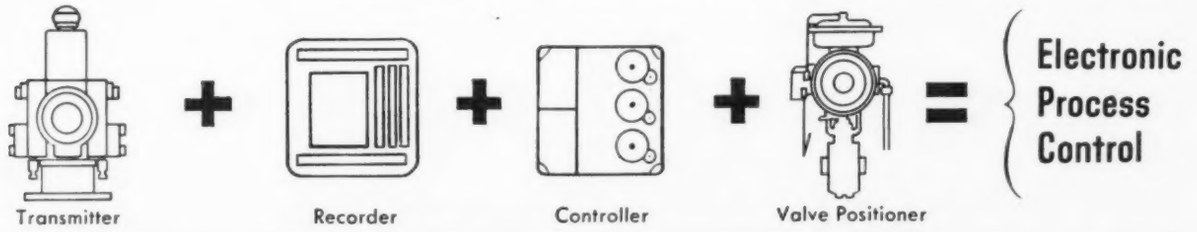

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Crops *and* Shorts

△ The "strike-bound" 1959 annual convention of The Association of Iron and Steel Engineers was not the "dud" many thought it would be. The total registration of 2477, including 192 ladies, showed some effects of the strike, but equaled the 1955 registration in Chicago. Technical session attendance was better than average, with standing room only in some. Unfortunately, the inspection trip to Inland Steel's Indiana Harbor Works had to be cancelled because of the strike.

The Association appreciates the cooperation of all who helped make the convention a success. We are glad that wise managements recognize the educational value of these meetings and encourage their men to attend.

△ As of this writing, the steel strike is 85 days old, longest in the industry's history. By the time this appears in print, the mills may be operating again, probably under provisions of the Taft-Hartley act, which really means no settlement. We can only hope that the voting by union members, as set up in the act, will open their leaders' eyes.

△ As the strike dragged along, steel shortages brought back a number of long gone practices. The gray market showed up again, with price premiums of $100 a ton or more. Conversion deals, excessive shipping distances, imbalance of steel types in inventories, warehouses in the wholesale business—all showed the pinch of the strike.

△ Now that they have devised all kinds of fancy filters and treatments to make cigarets less irritating, they might start working on their TV commercials.

△ Another "largest" had its start with a contract let by Jones & Laughlin Steel Corp. for a blast furnace with a 32-ft hearth diameter. To be built at the company's Cleveland Works, the furnace will be 110 ft high, with a working volume of 65,000 cu ft and a daily rated capacity of 3500 tons of iron.

△ A correspondent tells us of a pink elephant, a green kangaroo and two yellow snakes strolling into a bar. "You're a little early boys," said the bartender. "He ain't here yet."

△ August, the first full strike month, showed U. S. steel production at 1,438,000 tons, for an operating rate of 11.5 per cent of capacity.

△ One of the most alarming aspects of our time is the too general belief that money comes from the government.

△ Perhaps it's a sign of the times that the bulge in most of our wallets comes from credit cards.

△ Research and development budgets in approximately 600 U. S. corporations are 12 per cent higher than 1958's record outlay, according to the American Management Association. Of 12 steel companies, five report larger budgets, one is the same and six are lower. Overall, the 1959 budgets are 2.4 per cent higher than 1958. In 1958, these companies spent 1.1 per cent of the sales dollar going for research and development.

△ A recent editorial mentioned that Walter Reuther asked Nikita Khrushchev how he could say American workers were slaves of capitalism when they made such high wages. The editorial attributes a possible source of Mr. K's information to statements Mr. Reuther makes whenever contracts come up for renewal.

△ An award for direct mail was given to Albany Products Inc., Norwalk, Conn., distributor of fasteners. Typical of their mailings is:

"Roses are red
Violets are blue
We love to sell
NUTS TO YOU!"

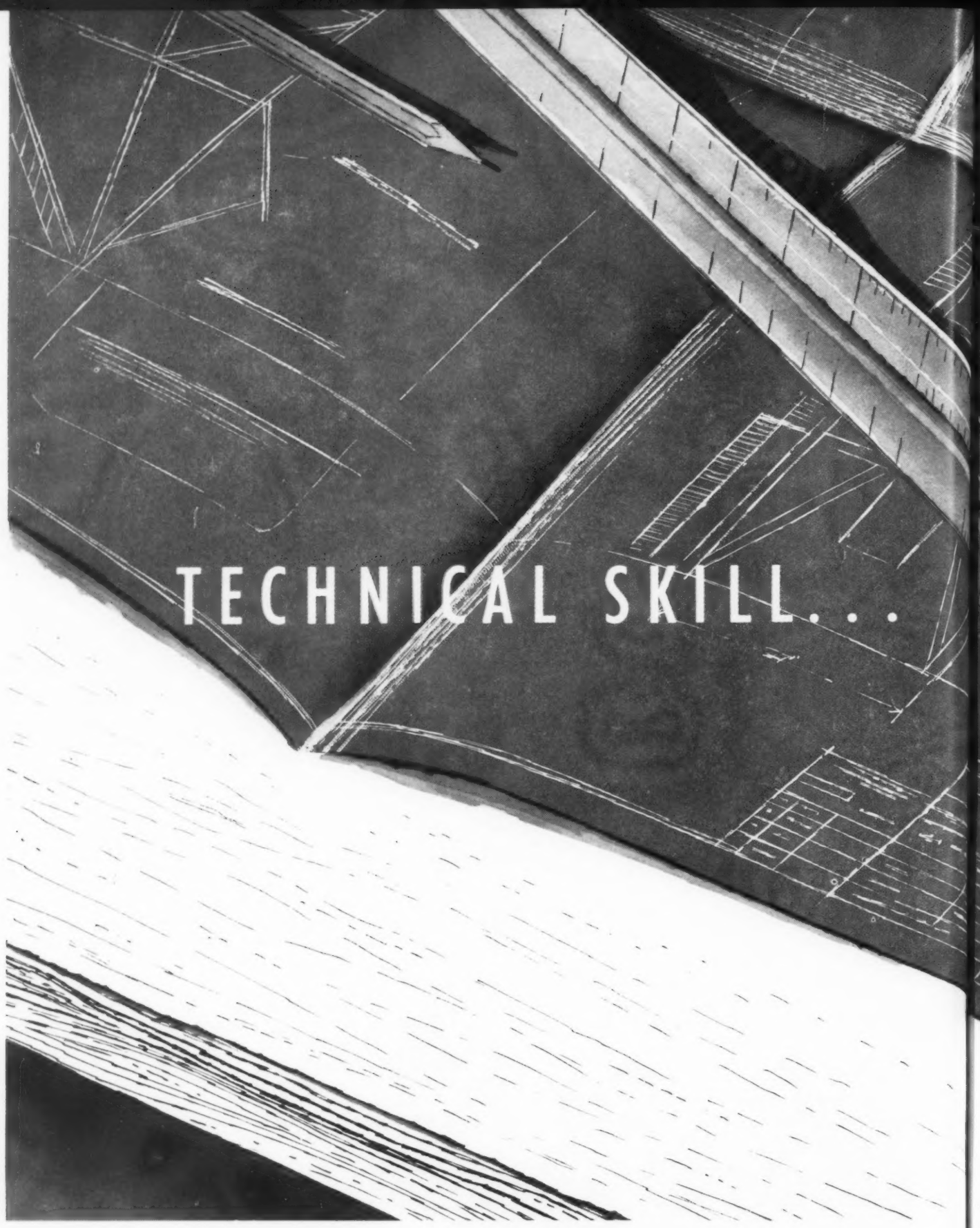
That requires careful punctuation.

△ The Wall Street Journal says that any man who thinks he's more intelligent than his wife is married to a smart woman.

△ The steel industry continues its fine safety record. Figures for 1958 show a frequency rate of 3.21 accidents per million man-hours worked, a new record nearly 8 per cent under 1957, and only slightly over half the rate for all industry. Steel's severity rate also dropped about 9 per cent in 1958, showing 728 days lost per million man-hours worked.

△ Detroit is apparently beginning to realize that a lot of Americans want a two-car garage rather than a two-garage car.

△ The steel industry was hit by 788 wildcat strikes in the past three years despite an agreement with the United Steel Workers of America that there would be no strikes during the duration of the recently expired contract, according to T. F. Patton, president of Republic Steel Corp.



Overhead Cranes * Gantry Cranes * Mill Cranes and Equipment * Hot Metal Cranes * Ladle Cranes * Stripper Cranes * Soaking Pit Cranes * Soaking Pit Cover Cranes * Charging Machines * Furnace Chargers * Slab Handling Cranes * Bucket Cranes * Magnet Cranes * Mold Yard Cranes * Skull Cracker Cranes * Ingot Buggies * Run-Out Tables * Car Dumpers * Special Mill Equipment * Ore & Coal Bridges * Loading & Unloading Towers Forging Manipulators * Forging Cranes * Power House & Dam Cranes * Dock & Pier Handling Equipment * Research, Development & Engineering Service * Licensees & Manufacturing Facilities in Other Countries.

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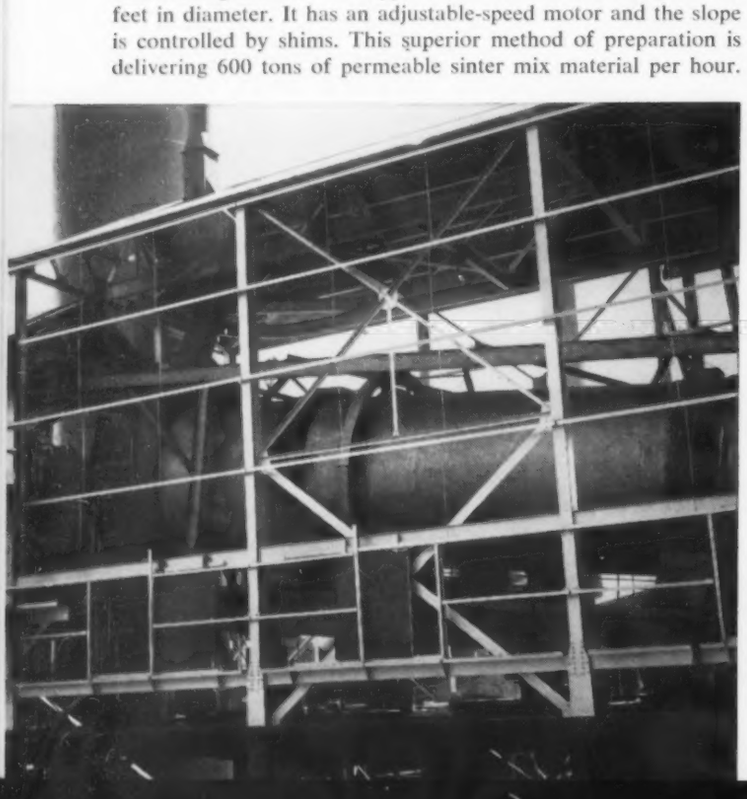
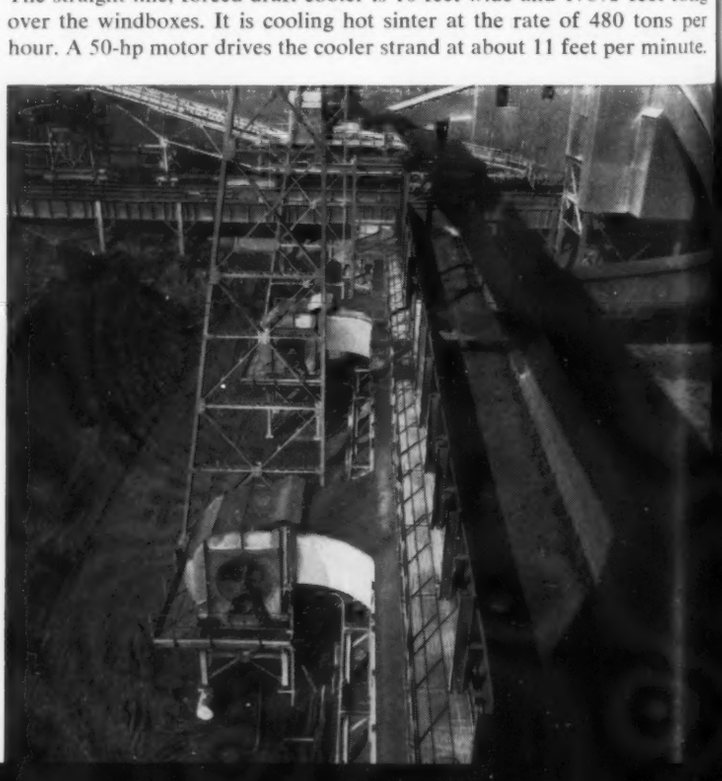
This balling drum is the biggest ever used—50 feet long and 12 feet in diameter. It has an adjustable-speed motor and the slope is controlled by shims. This superior method of preparation is delivering 600 tons of permeable sinter mix material per hour.



The straight-line, forced-draft cooler is 10 feet wide and 178½ feet long over the windboxes. It is cooling hot sinter at the rate of 480 tons per hour. A 50-hp motor drives the cooler strand at about 11 feet per minute.



Operatio
controlle
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S STEEL SETS INDUSTRY RECORD

Operation of the sintering plant and materials handling systems is controlled from this panel board, located at the feed end of the sintering machine. It's the largest iron ore sintering machine in the world.

8,400 tons of sinter per day in new plant built by KOPPERS

It's the largest iron ore sintering machine in the world —12 feet wide and 200 feet long over 19 double windboxes. It's a giant, but operates with a very high efficiency. Total output of 8,400 tons from *one* machine in a single day is a new record for sintering.

This plant is part of the continuing expansion program at the Zug Island Works of Great Lakes Steel, a Division of National Steel Corporation. The company foresees a hot metal production increase of 20 to 30%, due largely to the sintering and ore handling facilities designed and built by Koppers Company, in cooperation with engineering and operating personnel from National Steel.

The new facilities include an ore handling system, an ore crushing and screening station, a miscellaneous materials handling system, a sintering plant, and a sinter handling system. The installation has 84 conveyors, with widths up to 48 inches and capacities to 1,250 tons per hour.

Many of the features in this installation are entirely new to commercial plant operation. You might be interested in the complete story, which is covered in an 18-page booklet, "Ore Handling and Beneficiation at Great Lakes Steel." For a free copy, please write to Koppers Company, Inc., Engineering and Construction Division, Room 1124, Pittsburgh 19, Pa.

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KOPPERS

ENGINEERING AND CONSTRUCTION

Wheelabrator mechanical descaler for cleaning skelp.

Another example of Steel Industry Savings with Wheelabrator® Mechanical Descaling

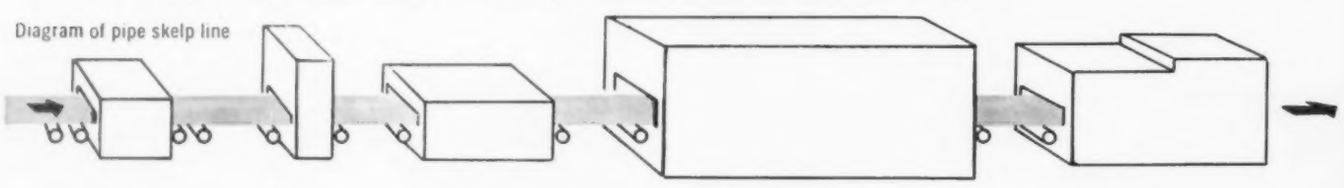
Wheelabrator mechanical descaling equipment, now being used to clean pipe skelp edges, serves to underline the versatility this process holds for the steel industry and shows the high degree of control that can be achieved.

In preparing pipe skelp for electrowelding, only a small strip along either edge of the bottom side of the skelp must be cleaned to bare virgin metal to the copper electrodes. Finish on the surface of the pipe, of course, is not critical.

In Wheelabrator equipment, a blasting wheel is positioned under each edge of the skelp so that the blast pattern is parallel with the length of the skelp. As skelp passes through the Wheelabrator there is fast, thorough cleaning of edges without wasting power or abrasive on areas that do not need to be cleaned.

For information on savings you can make with Wheelabrator equipment in all phases of steel descaling, write today for your copy of Bulletin 128-D.

Diagram of pipe skelp line



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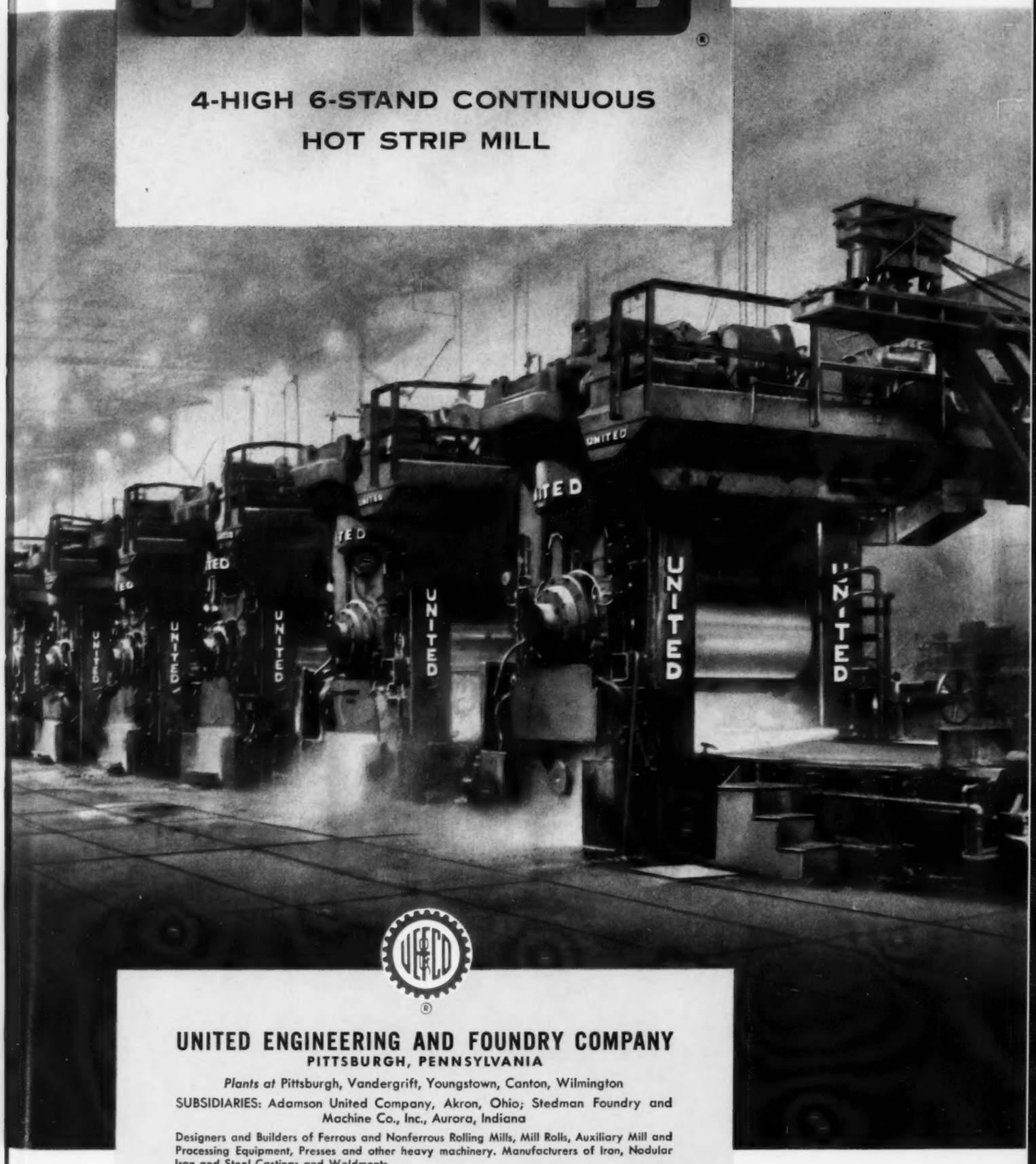

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UNITED ENGINEERING AND FOUNDRY COMPANY
PITTSBURGH, PENNSYLVANIA

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SUBSIDIARIES: Adamson United Company, Akron, Ohio; Stedman Foundry and Machine Co., Inc., Aurora, Indiana

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Compare ACCURACY! The "Transistomatic" does not base its "sensing" action on spark *frequency* alone—or spark *intensity* alone. Instead, it continuously integrates BOTH frequency and intensity to establish an overall "power value" that provides a new standard of control accuracy!

Compare DEPENDABILITY! The "Transistomatic" unit contains no parts of any kind requiring regular replacement. Moreover, the entire unit is completely sealed—moisture-proof and watertight.

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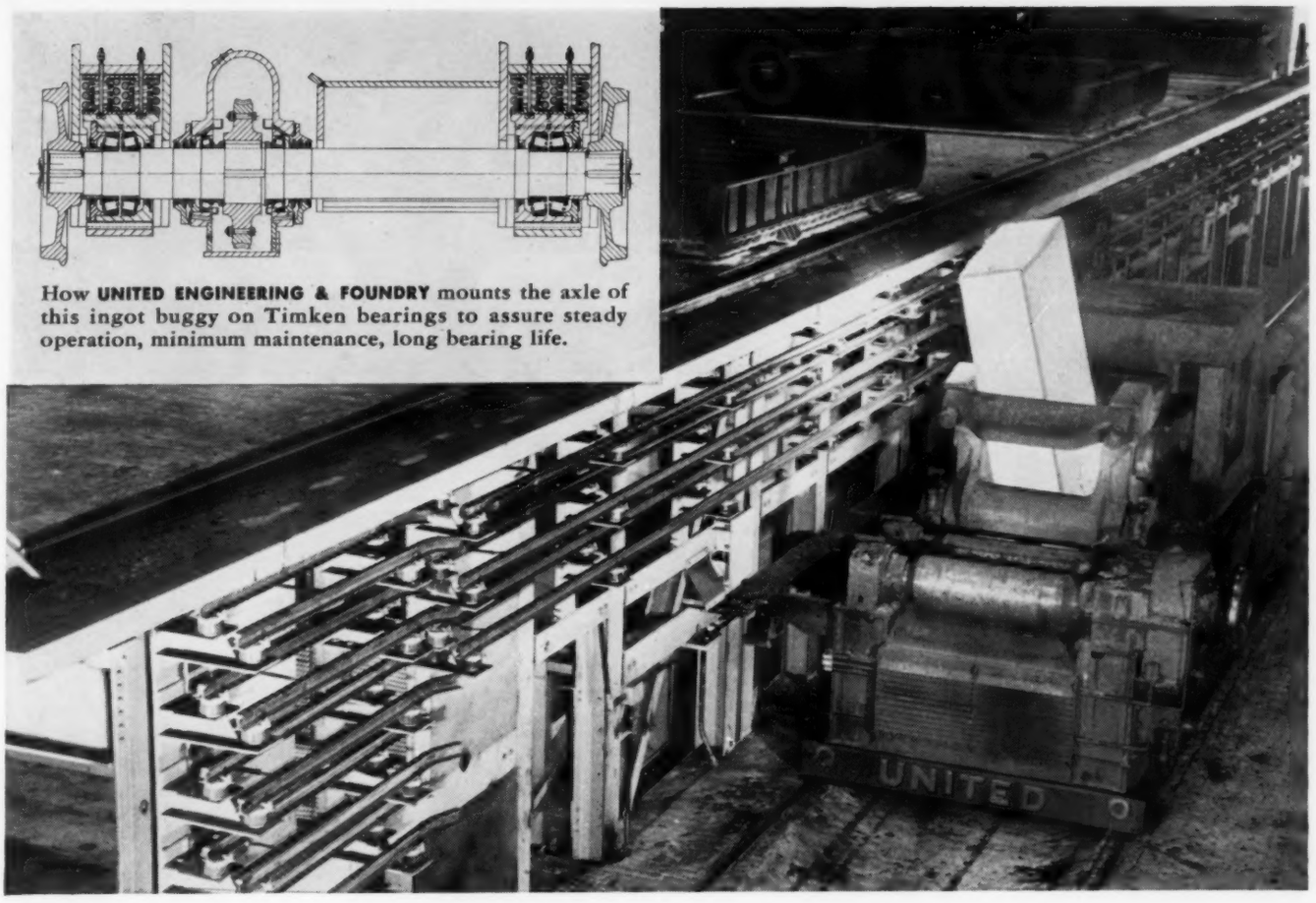
How **UNITED ENGINEERING & FOUNDRY** mounts the axle of this ingot buggy on Timken bearings to assure steady operation, minimum maintenance, long bearing life.



Keeps hot slabs moving fast with 27 Timken® bearings to keep it rolling

THIS United ingot buggy moves hot slabs and keeps 'em moving fast from a major steel producer's slab mill. To make sure the buggy moves the heavy loads steadily, with minimum maintenance, its builders, United Engineering & Foundry, equipped it with 27 Timken® *tapered* roller bearings. They're used on the axle drive worm shaft, axle journals, worm gear tilting drive worm shaft and tilting drive pinion shaft because Timken bearings:

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Any machine with Timken bearings gives you *extra* benefits—the benefits of Timken Company leadership in tapered roller bearing design and in engineering service. It's leadership backed by the most modern research and development facilities in the bearing industry. To get the most out of the machines you build or buy, specify Timken bearings. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable: "TIMROSCO". *Makers of Tapered Roller Bearings, Fine Alloy Steels and Removable Rock Bits.*

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This photograph shows a heat-resistant alloy casting after thermal-fatigue failure.

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patent reviews

By MELVIN NORD, Patent Attorney, Detroit, Mich.

Copies of patents may be obtained from the Commissioner of Patents, Washington 25, D. C. at 25 cents . . . . patents reviewed cover period April 21, 1959 through May 19, 1959.

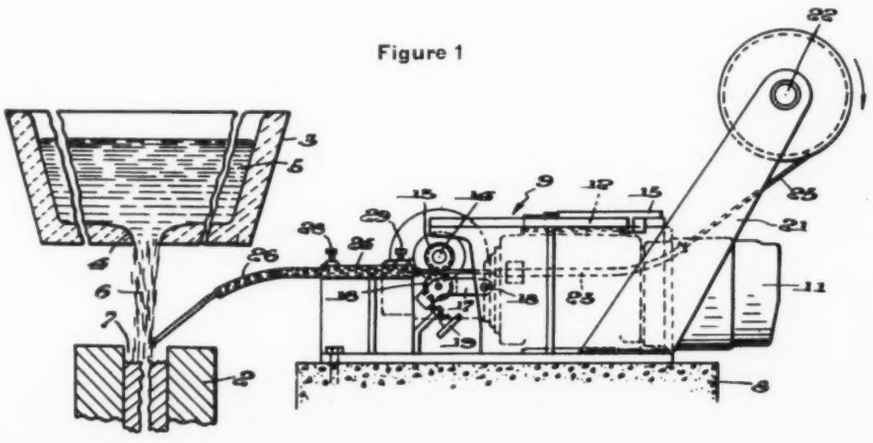
CONTINUOUS CASTING OF RIMMED STEEL

△ U. S. 2,882,571, issued April 21, 1959 to Rufus Easton, assigned to Koppers Co., Inc., describes a process of continuously casting rimmed steel, which includes the feature of introducing a deoxidizing agent into the mold in such a manner that only a light, readily removable scum is formed along the molten metal surface.

In carrying out the present invention as shown in Figure 1, a deoxidizing agent such as an aluminum wire spool is mounted on the spindle 22. Simultaneous with the pouring of the metal 5 from tundish 3 as a stream 6, the wire is fed by feed rolls 13, 16 through the guide 23, guide 24, guide end 26, and into the stream 6 of molten metal, the wire entering the stream at a point above the molten metal level in the mold 2.

The velocity and kinetic energy of the metal stream entering the mold carries the deoxidizing agent deep down into the casting, the deoxidizing agent mixing with the metal already present and rising along the solidifying casting walls. When gas evolution occurs, it is not in large bubbles, but only in the form of very small bubbles of very great numbers which rise along the solidifying wall. The large bubbles are eliminated as well as a thick, scum layer at the top of the mold.

Figure 1



METHOD FOR FREEING STOPPER ROD

△ U. S. 2,883,722, issued April 28, 1959 to John Bidner, discloses a method for reducing the formation of a frozen "skull" of steel between the stopper rod and the ladle nozzle, and for freeing the stopper rod for opening and closing movement. This is accomplished by providing a body of molten lead around the bottom of the stopper rod and in contact with the pouring nozzle to prevent the formation of frozen steel in this area.

As shown in Figure 2, lead shot is poured cold into the trough 46 after the stopper rod 26 has been positioned down in sealing relation with the nozzle block 18 and before any molten steel is poured into the ladle 10.

As soon as the molten steel comes in contact with the lead, the lead melts. But the lead being heavier than steel remains in the trough 46. The lead does not readily mix with the steel, nor does it easily oxidize. The molten lead between the lower end of the stopper rod 26 and the nozzle prevents steel from solidifying in this same area. Thus there is no bond or locking between the stopper rod and the nozzle, and the stopper rod, even after a considerable time interval, can be readily lifted from

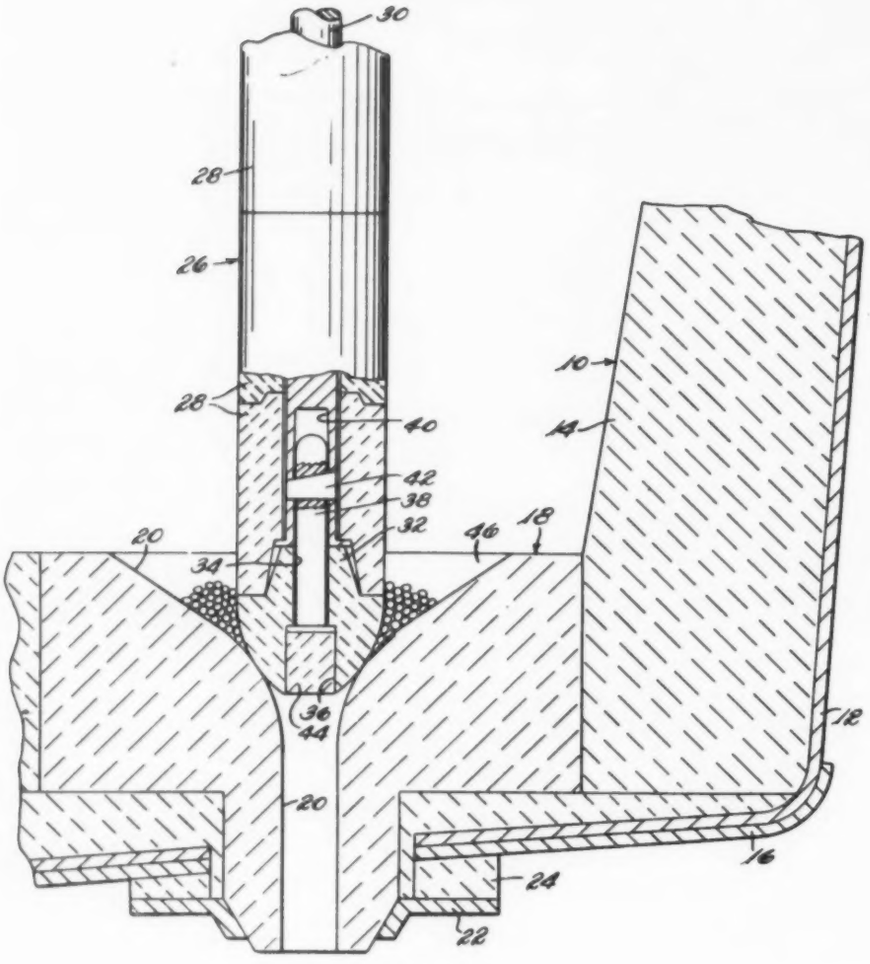


Figure 2

the mechanism at the top of the ladle to initiate the pouring of the steel. Of course, the lead flows out with the first steel poured and a portion thereof remains in the first dish of the mold stool, and a portion is partially oxidized when it comes in contact with the atmosphere.

DESULPHURIZATION OF MOLTEN IRON

△ U. S. 2,884,321, issued April 28, 1959 to Alexander J. Macdonald, assigned to National Steel Corp., describes a method for desulphurization of molten pig iron with soda ash.

As shown in Figure 3, a mixed stream of powdered soda ash (from hopper 51) and compressed air is injected into the molten pig iron flowing through the runner 40.

When the soda ash comes into contact with the molten iron it dissociates under the existing temperature conditions forming sodium oxide and sodium vapor both of which have a strong chemical affinity for sulphur and react with the sulphur in the molten iron reducing the sulphur and producing resulting products which collect on the surfaces of the molten metal for removal in any convenient manner. It has been determined from actual operation that the method and apparatus provided by the present invention effects desulphurization of pig iron at a higher efficiency than obtainable from prior methods in that a higher degree of sulphur reduction is obtained for a given rate of soda ash introduction even when using lower grades of soda ash.

METHOD OF CENTERING A BLAST FURNACE BELL

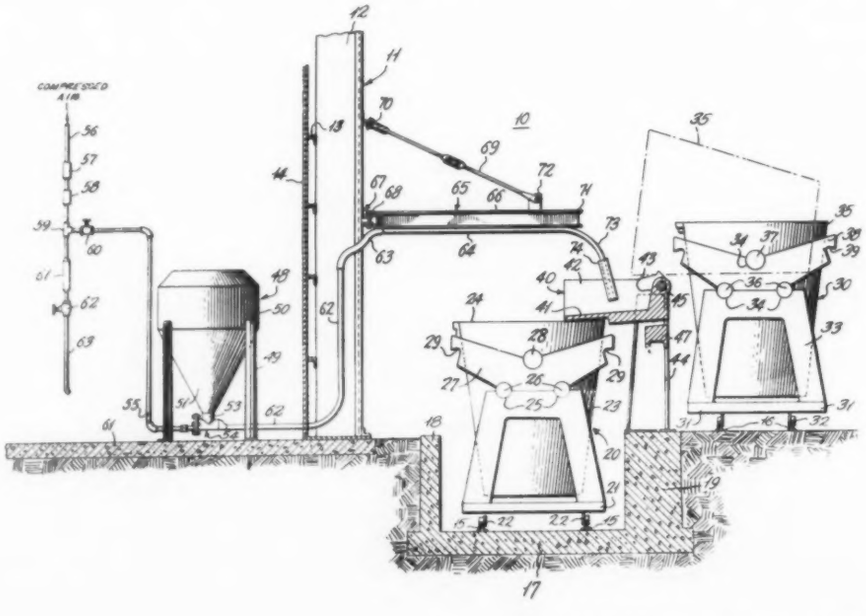
△ U. S. 2,885,773, issued May 12, 1959 to Gregory R. Molinaro, assigned to United States Steel Corp., describes a method of centering the large bell with respect to the hopper, in the erection or repair of a blast furnace.

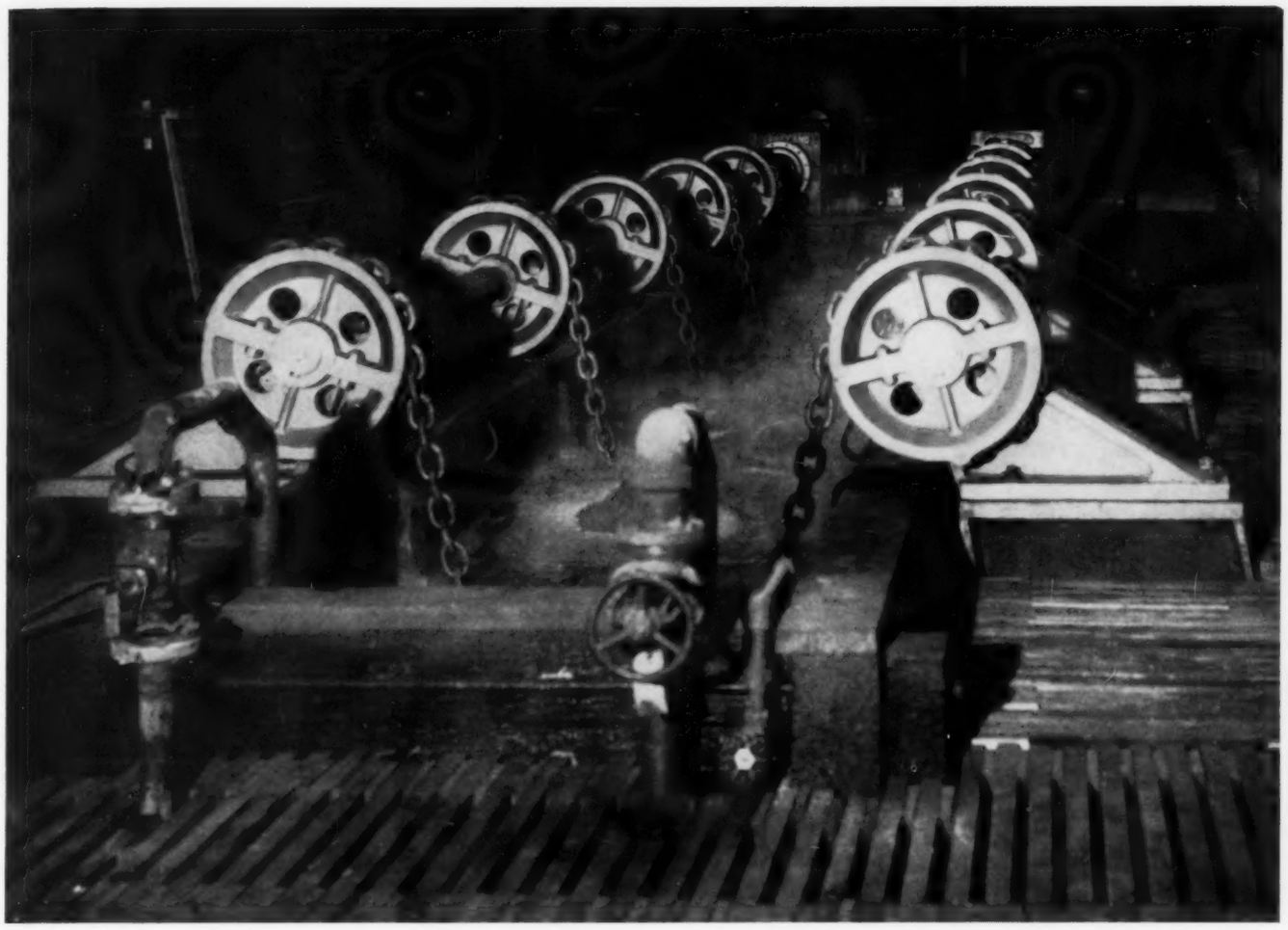
As indicated in Figure 4, the information required for the adjustment of the pillow block is obtained by the use of a tool 26, which is used to determine the eccentricity of a portion 27 of the external surface of the bell rod 8. The bell is centered relative to the hopper by centering the position of the bell rod 8 with respect to accurately centered reference points on the upper end of the hopper.

COOLING BENCHES

△ U. S. 2,885,200, issued May 5, 1959 to William C. E. Bell and Frederick L. Smith, relates to cooling benches for cooling hot sintered material such as sintered ore pre-

Figure 3





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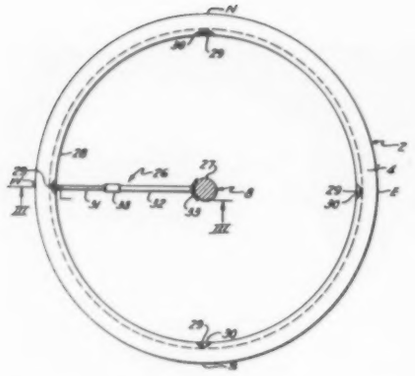


Figure 4

paratory to its loading onto an endless belt conveyor for dispatch to storage.

As indicated in Figure 5, cooling air from fans 42 cools the hot sintered material, by passing through the space between the overlapping shelves 28.

PRE-MELTING AND SUPERHEATING OF SCRAP IRON

△ U. S. 2,886,304, issued May 12, 1959 to James M. Guthrie, describes a furnace for melting and superheating unprepared scrap at a rate to meet the charge requirements of several open hearth or electric steel-producing furnaces; for example, one furnace may serve from five to seven 200-ton open hearth furnaces.

As shown in Figure 6, the charge of scrap in the maw furnace extends downward from the top of the furnace in a column that may range from ten to twenty-five feet in height. Beneath the column of scrap in the furnace, fuel burners develop an intense heat, and below the burners a hearth forms a receptacle for holding more than the quantity of superheated molten steel scrap required for an open hearth charge. The heat developed in the furnace melts the scrap at the lower end of the column, while the products of combustion rise through the column and preheat the scrap above the melting zone and while it is descending through the furnace hopper. The efficiency of the furnace is above 80 per cent, as compared with a scrap-melting efficiency of approximately 32 per cent of the conventional open hearth furnace.

The maw furnace is lined with neutral refractory material such as

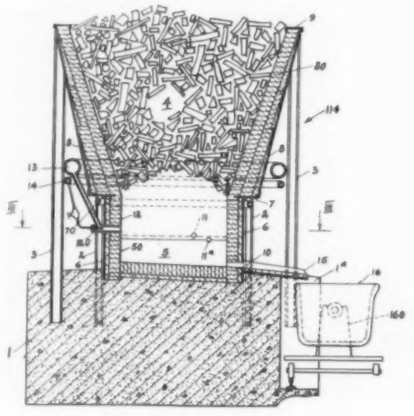


Figure 6

70 per cent alumina, or chrome, or magnesite brick, and the furnace is fired in such manner as to yield high temperatures, with products of combustion that are highly oxidizing. During the melting and superheating of the scrap a preliminary refining of the metal takes place; that is, parts of the silicon, manganese, carbon and iron are oxidized. The oxides of carbon escape with the products of combustion of the fuel, while the oxides of iron and manganese combine with the silica to form a highly oxidizing slag which is collected with the molten scrap delivered into the ladle for transfer to the open hearth furnace.

DISPOSAL OF OPEN HEARTH SLAG

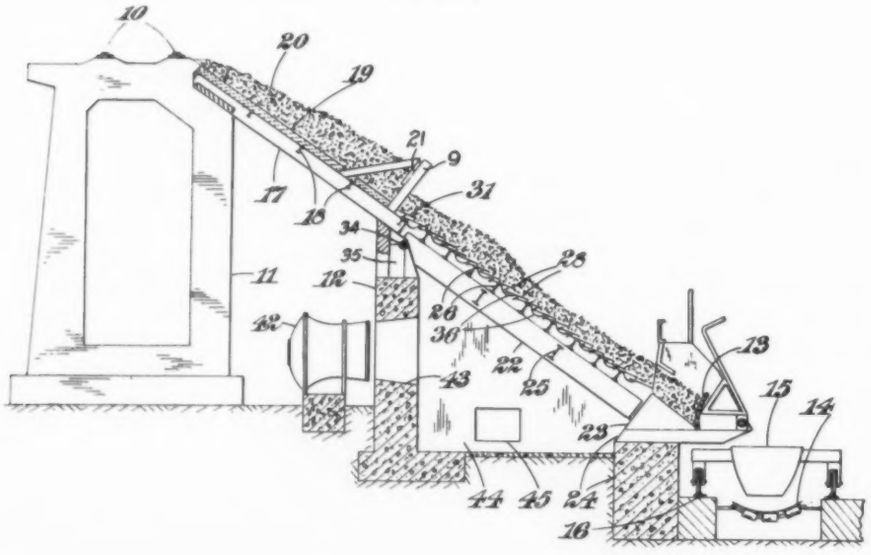
△ U. S. 2,887,225, issued May 19, 1959 to Eric H. Heckett, assigned to Harsco Corp., describes a method of disposing of the slag and refuse resulting from the full scale operation of an open hearth steel plant.

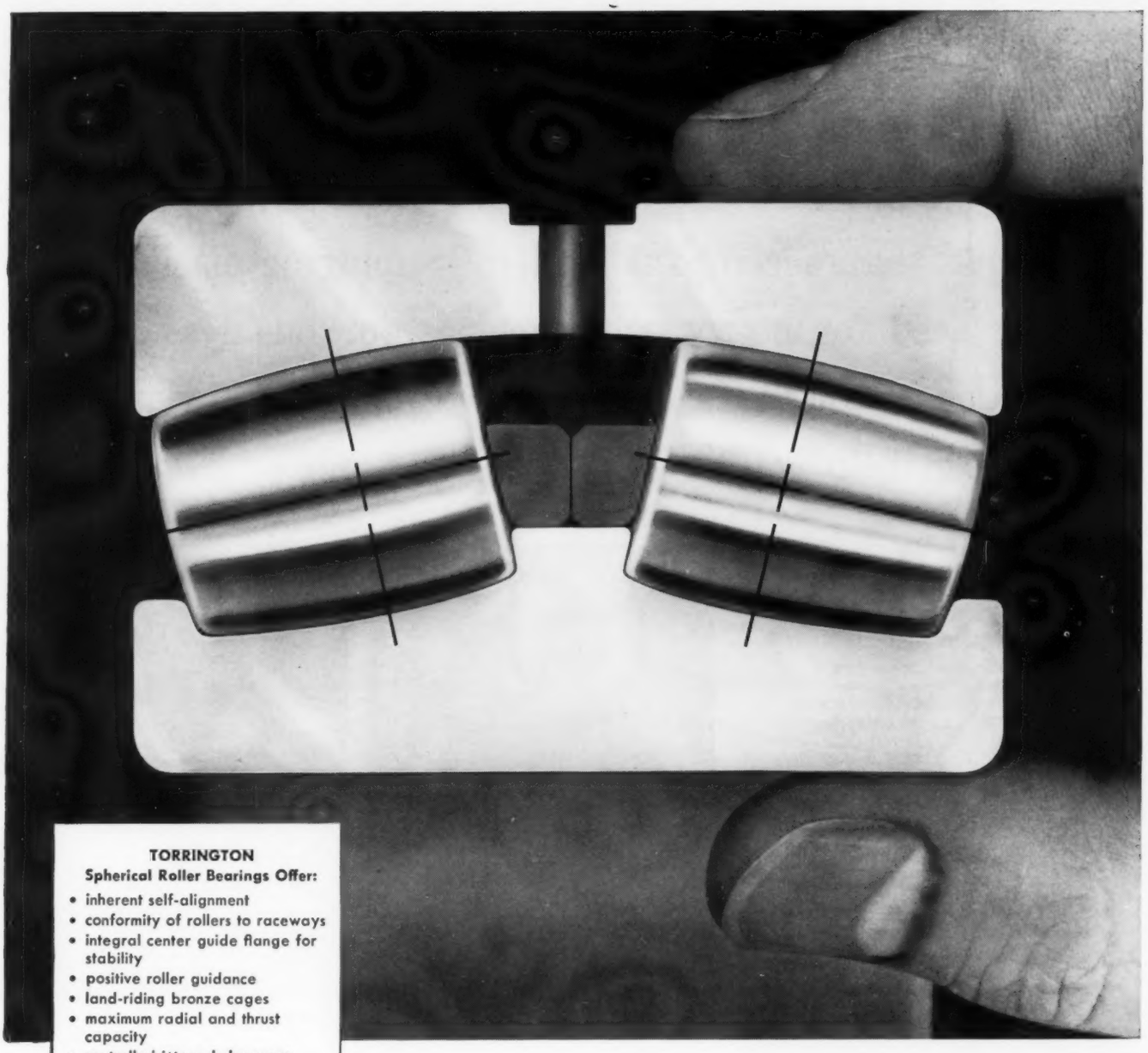
In Figure 7, the reference numeral 10 represents an open hearth steel mill from which the slag and general refuse may be hauled away over a railroad track 11. In an area designated generally by the reference numeral 12, at least two elongated pits 13 and 14 are provided, which are axially alined as shown in order that both sides of each pit may be conveniently served with railroad trackage—the track 11 running along one side of the pits while a branch line 15 runs along the other side of the pits. The area 12 is preferably located in a leveled section of an existing slag and refuse dump since the porosity of this fill material is an outstanding advantage in keeping the pits 13 and 14 clear of free standing water. Violent and dangerous explosions occur if the molten open hearth slag is poured into containers or pockets containing water.

Reference numeral 16 designates refuse cars which are of the conventional dumping type having air-operated means, whereby the load may be dumped to one side and into one of the pits while the trucks of the cars remain fixed on the track. A locomotive is shown at 17 and the assembled slag pots and transporting cars therefore are shown at 18.

Reference numeral 32 designates a conventional crawler type of dragline crane. The crane 32 is of usefulness not only in dumping the slag pots but in excavating the slag and refuse from the pits 13 and 14, and subsequently handling such material, and in separating therefrom reusable iron and steel scrap. There are shown two such cranes 32, one

Figure 5





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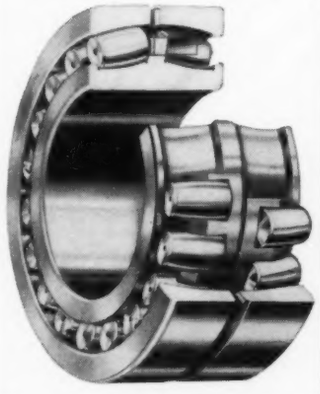

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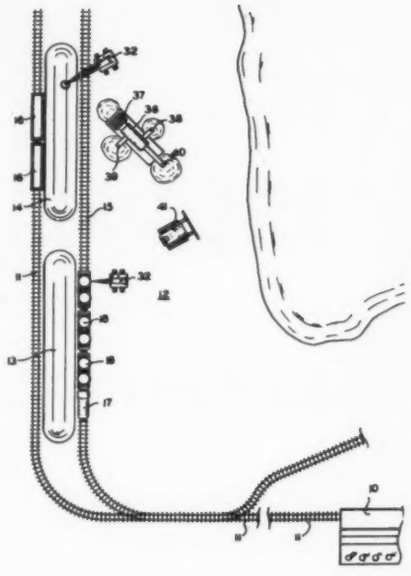


Figure 7

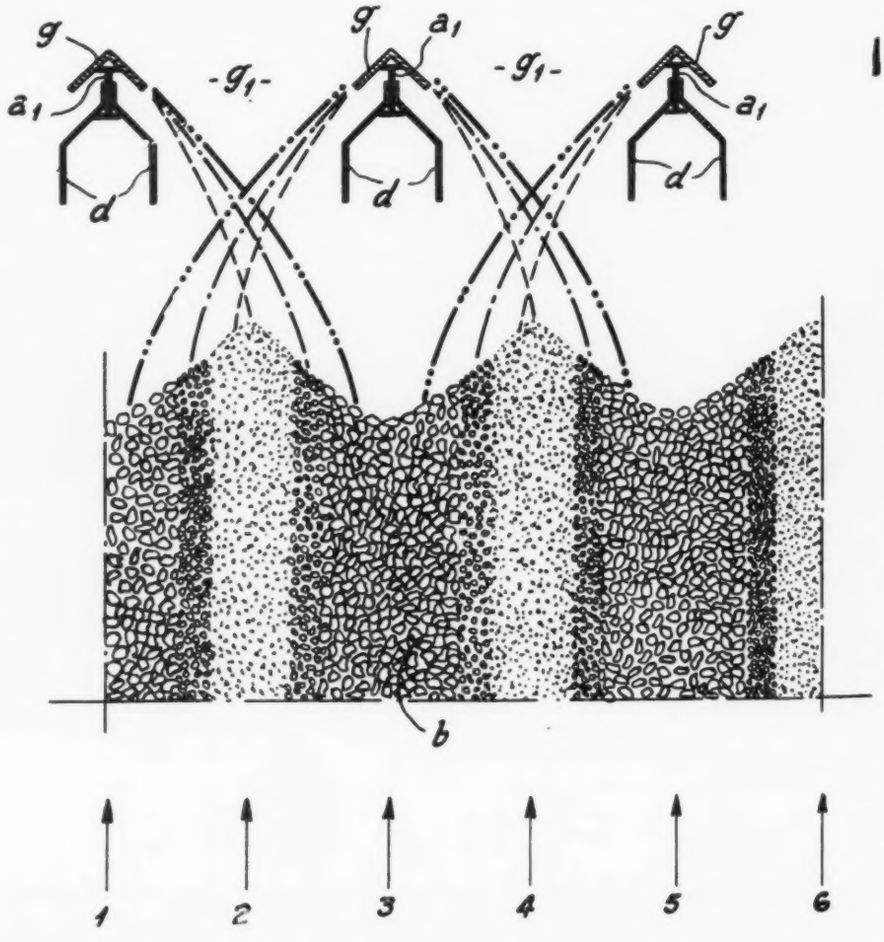
adjacent the slag cars which are shown positioned on track 15 by the side of pit 13 and the other in operating position over the pit 14. Reference numeral 36 designates a portable magnetic separation plant, having an inclined loading grid 37, a conveyor 38 for the discharge of magnetic fines and a conveyor 39 for the discharge of larger pieces of magnetic material or vice versa, and a conveyor 40 for the discharge of all nonmagnetic materials. The waste refuse material and slag from which all the reusable metal has been reclaimed is removed and leveled by conventional earth moving equipment such as a bulldozer 41.

The patent describes the operation of the plant in further detail.

OTHER PATENTS OF INTEREST TO THE IRON AND STEEL ENGINEER

Patent No.	Date	Subject	Inventor or Assignee
2,883,895	4/28/59	Rolling mill thickness control system	Carl A. Vossberg
2,883,925	4/28/59	Bundling apparatus	United States Steel Corp.
2,884,063	4/28/59	Shears for channels	The Allen Iron & Steel Co.
2,884,130	4/28/59	Apparatus for sorting steel plates	Julius Bosch
2,884,320	4/28/59	Agglomeration of fine ore	United States Steel Corp.
2,884,338	4/28/59	Method of oiling tinplate	National Steel Corp.
2,884,351	4/28/59	Cold rolling of ferrous strip stock	Parker Rust Proof Co.
2,884,896	5/5/59	Strip-tinning device	Western Electric Co., Inc.
2,885,201	5/5/59	Cooled sinter grate	Sydney T. Evenstad
2,885,284	5/5/59	Cast iron alloy	Mechanite Metals Corp.
2,885,285	5/5/59	Alloyed nodular iron	Allis-Chalmers Mfg. Co.
2,885,751	5/12/59	Vacuum casting apparatus	United States Steel Corp.
2,885,752	5/12/59	Production of fully-killed steel with rimming characteristics	United States Steel Corp.
2,886,170	5/12/59	Method for drawing tubes	Wallace E. Kerr
2,886,303	5/12/59	Carburizing furnaces with recuperative heating	Metallurgical Processes Co.
2,886,313	5/12/59	Cover lifting device for an electric furnace	Demag-Elektrometallurgie G.m.b.H.
2,886,428	5/12/59	Manufacture of ductile high aluminum iron alloy	Osamu Madono
2,886,478	5/12/59	Carburizing apparatus	Minneapolis-Honeywell Regulator Co.
2,886,497	5/12/59	Determining the permeability of steel to hydrogen	United States Steel Corp.
2,886,498	5/12/59	Preparation of steel for enameling	Republic Steel Corp.
2,886,617	5/12/59	Tiltable arc furnace	Demag-Elektrometallurgie G.m.b.H.
2,886,993	5/19/59	Rolling mill trough	Birdsboro Steel Foundry & Machine Co.

Figure 8



DISTRIBUTION OF THE CHARGE IN A BLAST FURNACE

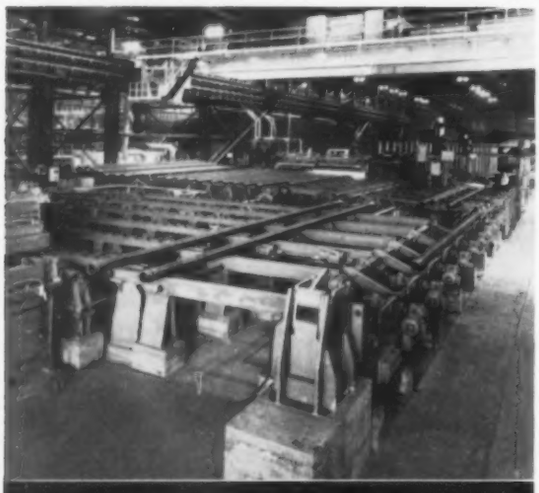
△ U. S. 2,886,306, issued May 12, 1959 to Henri H. Meynadier, describes a method for distributing the charge in a blast furnace.

As shown in Figure 8, the distribution device (which is located between the charging cone or bell and the upper level of the charge b) consists of a number of inverted gutters.

DISTRIBUTING THE AIR BLAST TO BLAST FURNACES

△ U. S. 2,886,307, issued May 12, 1959 to Floyd E. Demmon, assigned to United States Steel Corp., describes an apparatus for automatically distributing the air blast to blast furnaces.

Means are provided for changing the operation of the control during unusual conditions.



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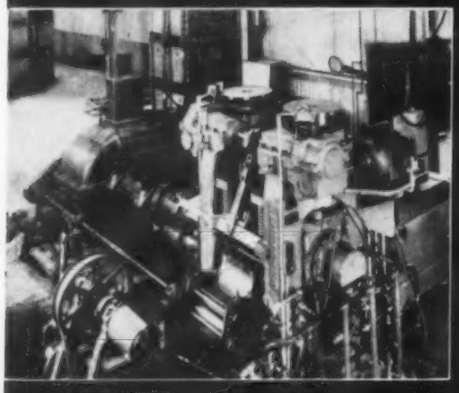
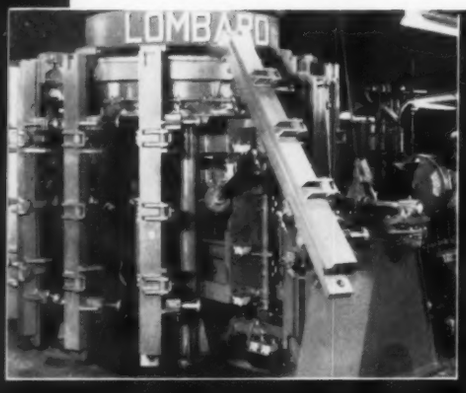


FOUR-HIGH ROLLING MILL



ANODE CASTING MACHINE

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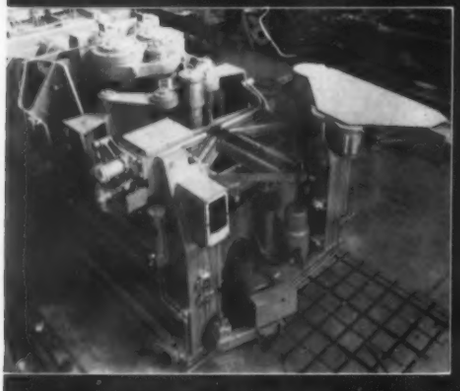
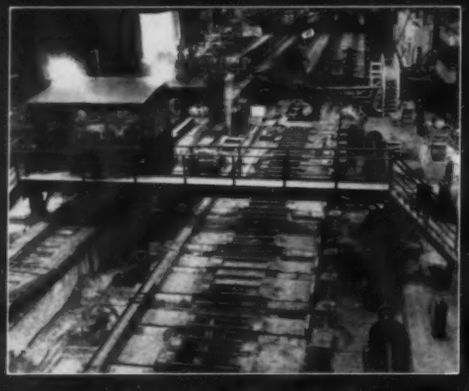
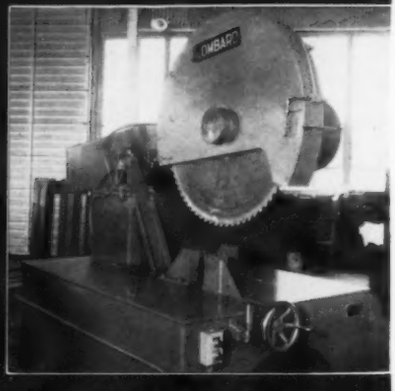


RING ROLLING MILL



BAR AND BILLET MILL



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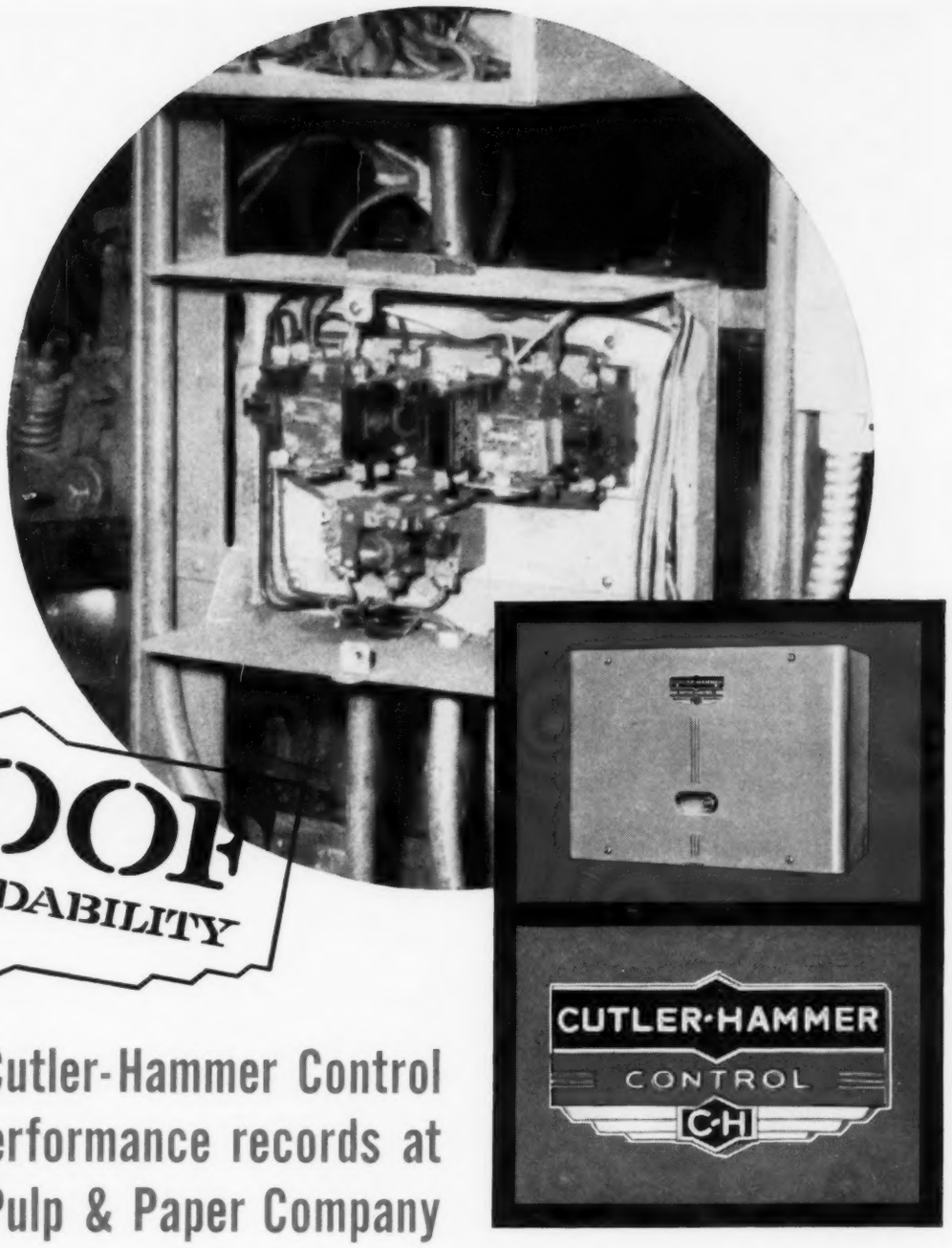

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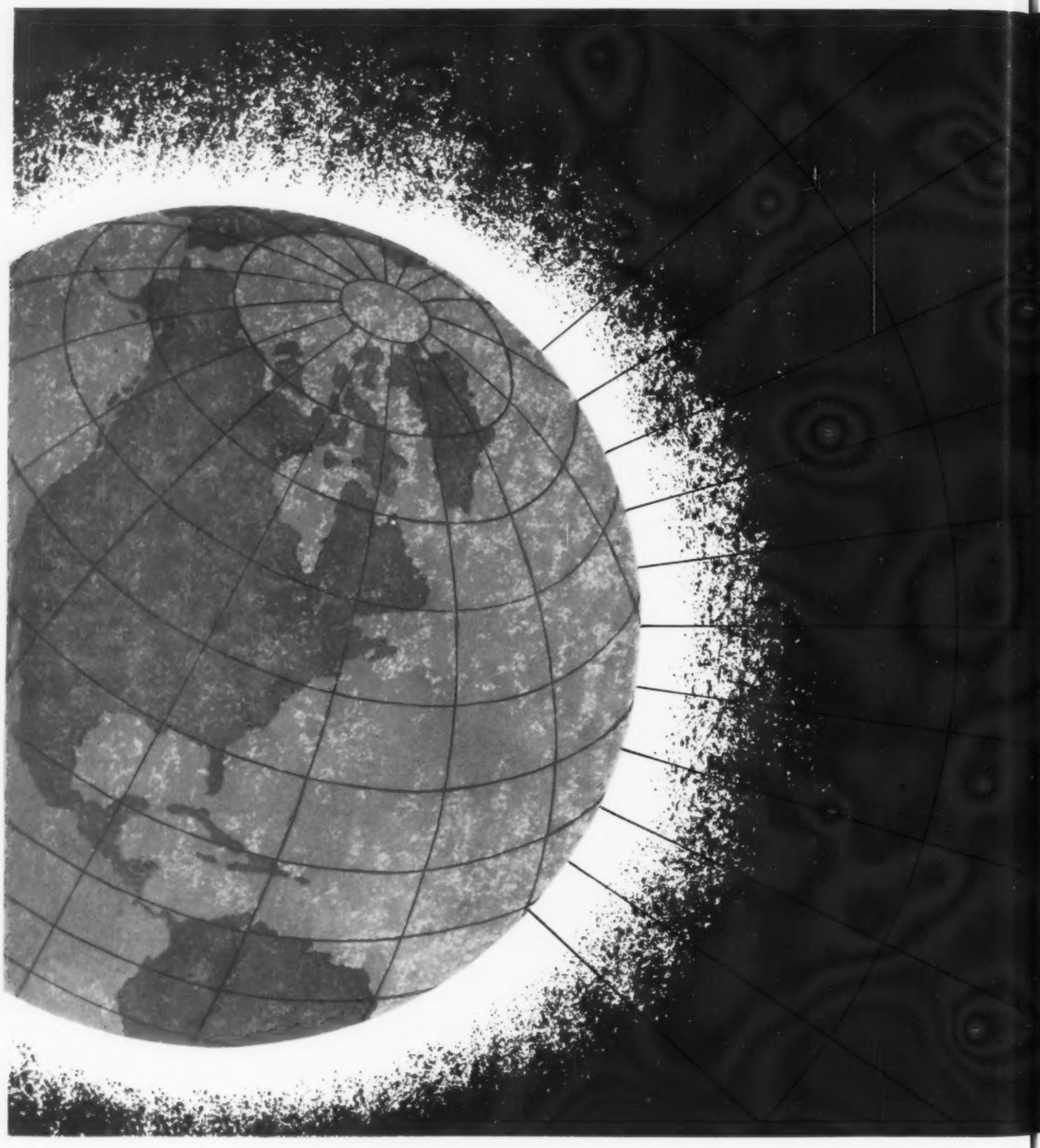

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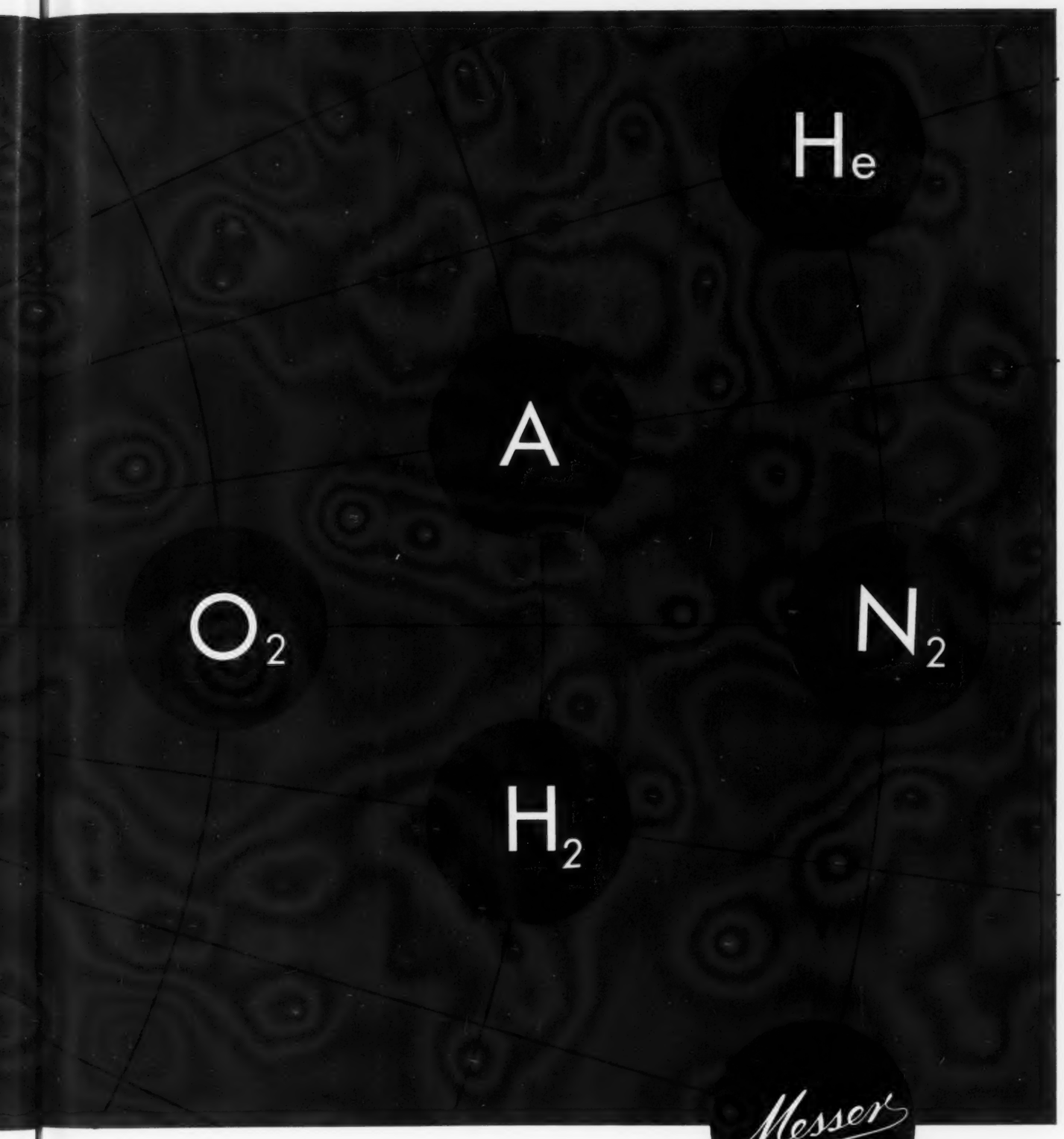

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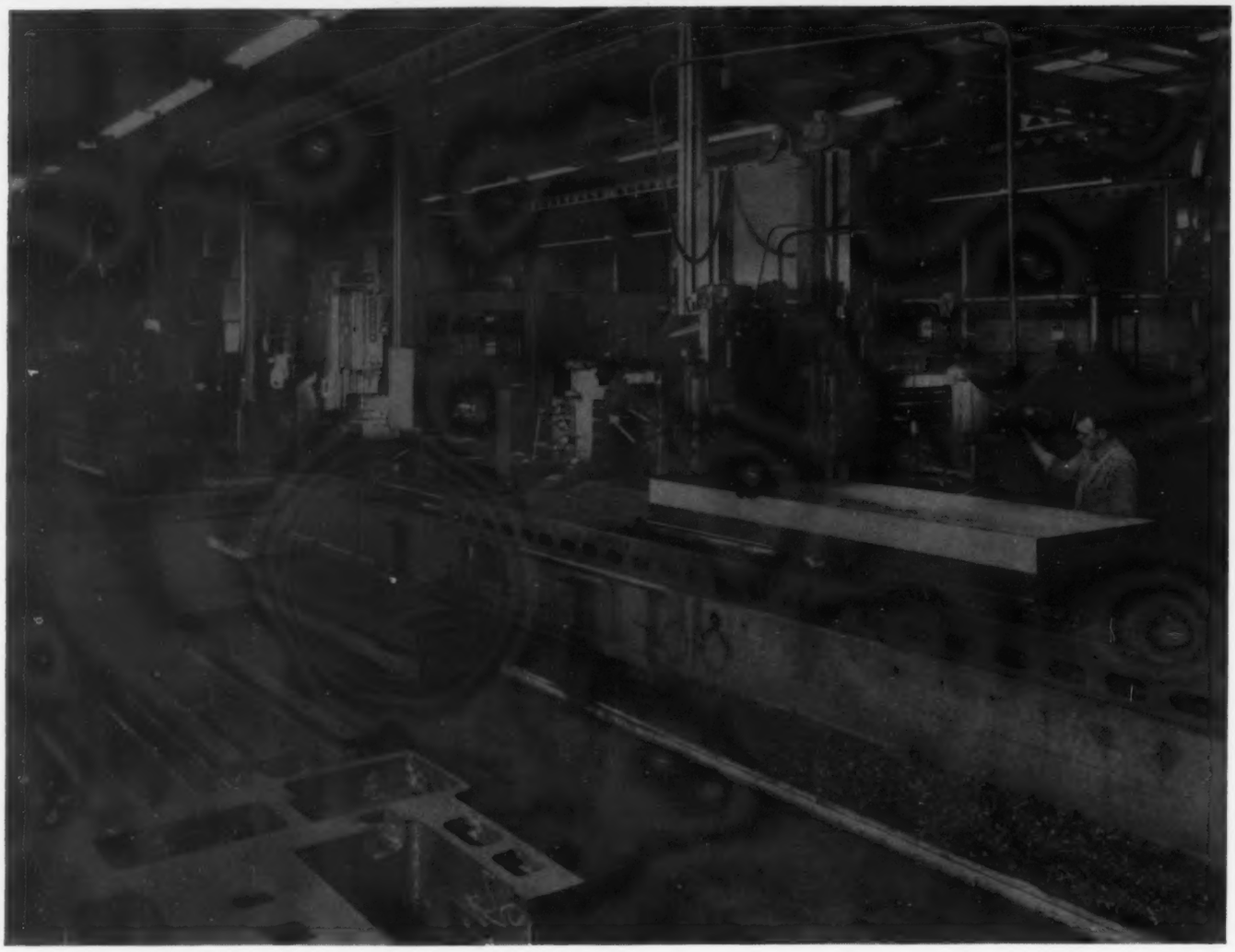

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Sept.-Oct. 1959

NATIONAL CARBON COMPANY'S

CARBON AND GRAPHITE NEWS

HOT METAL IN THE ELECTRIC ARC FURNACE

By R. Durrer and G. Heintze

HOT METAL IN THE ELECTRIC ARC FURNACE

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G. Heintze, *Chief Metallurgist*
Gesellschaft der Ludw. von Roll'schen Eisenwerke AG
Gerlafingen, Switzerland

By R. Durrer and G. Heintze

Introduction

This article is intended as a contribution to the direct refining of liquid pig iron in electric arc furnaces. The Frick-tal ore considered for smelting resembles in composition the Minette ore of Lorraine and produces a pig iron of high phosphorus content. In recent years, tests have been conducted at the Gerlafingen (Switzerland) steelworks of Ludw. von Roll'schen Eisenwerke AG, to refine liquid pig iron, and in particular high-phosphorus pig iron, in the arc furnace. Within the framework of the tests reported in this paper, low- and high-phosphorus pig irons were charged as up to 70% of the total charge weight in 12-ton and 40-ton arc furnaces, using ore as the main refining agent.

Ore Refining Problems

The main problem in using ore as the refining agent is control of the refining reaction at high refining rates. Continuous addition of ore in small quantities only permits carbon burn-off rates of about 0.3-0.5% C/h, which entails long heat times when large proportions of pig iron are used, together with a considerable drop in hourly throughput as compared with 100% solid charges. Charging large amounts of ore on to the furnace hearth or mixed with the solid charge materials can, as experience has shown, lead to non-uniform reactions associated with spontaneous ejection of slag and steel as soon as the bath has reached a high temperature.

Operating Technique

When scrap and liquid pig iron are charged together, the arcs proceeding from the electrodes melt vertical cylindrical or crater-shaped channels into the scrap projecting up from the liquid metal bath surface and tend to make direct contact with the pig iron covering the furnace hearth. This takes place faster when there is less scrap. The channels widen gradually under the influence of the arcs and can be considered for a limited period as self-contained crucibles or melting vessels, their walls being formed of scrap and their contents of liquid pig iron. As soon as the arcs reach the liquid pig-iron bath surface they try to form a closed circuit with the latter. Thus the heat produced is concentrated in a very confined space and is transmitted to the liquid metal. If the ore required to refine the pig iron is now added mainly in the immediate vicinity of the arcs playing on the bath, it enters into rapid and violent reaction with the accompanying elements contained in the pig iron. At the same time this reaction (at first locally confined) between the ore and the pig-iron carbon produces a pronounced effervescence in the slag formed; the arcs are completely covered and screened by it and subsequent rapid melting of the scrap is delayed. A considerable proportion of the heat produced by the arcs is expended in reduction of the ore by the accompanying elements in the pig iron. Further melting of scrap can only take place to a limited extent by the direct arc action and is mainly due to gradual heating from the already molten part of the charge in which the scrap is immersed. In this way not only is the reaction centre, where the energy input is high, screened off so that the furnace walls cannot be directly affected by radiation from the arcs, but also the scrap still to be melted acts as an independent temperature regulator. Under these conditions the carbon burn-off reaction can be controlled by direct adjustment of the energy input.

Ore can be charged into this gradually widening crucible either by direct charging or by suitable mixing in the solid charge, so that the ore is mainly contained in the vicinity of the crucibles as they form and is exposed to the direct arc action at an early stage. The lime required can be handled in the same way, so as to ensure early slag formation.

When, after a certain time, the three separate crucibles first formed by the arcs come to break down, the ore already added will have largely dissolved in the slag and much of it will have already been reduced. The bath continues to boil uniformly and the ferrous oxide content of the slag to fall correspondingly until the required initial carbon content is reached. By estimating the ore quantity as closely as possible, with reference to the pig-iron analysis, scrap composition, and the extent to which the scrap is oxidized, the desired initial carbon content can be achieved with sufficient accuracy. The heat is finished in any required manner, as with ordinary scrap heats. When high-phosphorus pig iron is charged, the phosphate slag is removed at a higher carbon content and refining completed

This article is an abridgement of a paper published in the JOURNAL OF THE IRON AND STEEL INSTITUTE, May 1959.

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under a second low-phosphorus slag. When low-phosphorus pig iron is charged, the amount of ore can be estimated so that the initial carbon content is only a few points below the required final content and only a short time is needed to finish the heat.

Table I, gives the time-table for the heat, with the corresponding bath and slag analyses. It must be pointed out in connection with this table, that because of the refining process being repeatedly interrupted and because of the heat losses due to removing the roof, the melting time was considerably increased.

Time, min	Operation/ Condition	Steel C, %	Steel P, %	Slag P_2O_5, %	Slag Fe, %
0	Switch-on	3.50	1.770		
50	Remove roof sample 1	2.28	0.570	16.75	17.90
85	" " 2	1.58	0.275	14.47	10.82
115	" " 3	0.92	0.030	15.00	18.30
140	Scrap all melted sample 4	0.68	0.025	14.81	17.30
150	Sample 5	0.58	0.035	13.77	13.38

Table I. Changes in bath and slag composition during refining, with about 50% liquid high-phosphorus pig iron in the charge.

Furnace Data

Table II gives the most important characteristics of the arc furnaces.

Characteristic	40-Ton Furnace	12-Ton Furnace
Electrode control	electric-hydraulic	electric-hydraulic
Nominal size, tons	30	12
Charge weight, tons	38-42	13-15
Transformer rating, kVA	18,000	3,500
Primary voltage, v	45,000	3,000
Secondary voltage, v	370/129	200/81
Electrode material	Graphite	Graphite
Electrode diameter, mm	500	350
Secondary current per electrode, A	27,000	10,100
Method of charging	pan	pan
Inside dia. of casing, mm	5,200	3,200
Electrode pitch dia., mm	1,600	1,250

Table II. Characteristics of arc furnaces used.

Material Data

Typical pig iron compositions are contained in Table III. The temperature of the pig iron on charging into the furnace was about 1250-1300°C.

Operational Results

The overall melting time for a heat, reckoned from tap to tap, can be divided into three stages, the durations of which are influenced by different factors:

(1) *Charging and intermediate time.*
(2) *Melt-down time.*
(3) *Time for finishing the heat.*

In comparing different arc furnace melting techniques, i.e., in this case in comparing the all-scrap technique with the pig iron plus ore technique, one must first consider the melt-down times, the melting rates, and the corresponding energy consumption associated therewith. In the following, the times up to taking the first sample are compared for the two methods of working (the all-scrap technique and the pig iron plus ore technique), the first sample being taken with the melts in roughly the same condition. In the pig iron plus ore technique, the melt-down time includes melting the scrap and refining the pig iron. The finishing of the heat should then require about the same time for similar steel qualities, so long as the preceding refining period in the pig iron plus ore technique exerts no decisive influence on the further metallurgical progress of the melt until it is tapped.

Table III in addition to giving data on the charge, the pig-iron composition, and the steel composition at the first sampling, gives the melt-down time (from switch-on to first sample), the melting rate calculated from the latter, and the corresponding energy consumption for charges with around 50% liquid pig iron, against the results for 100% scrap charges.

Of the heats melted in the 12-ton arc furnace (groups 1-3), special mention should be made of those with high-phosphorus pig iron, since low-phosphorus pig iron was only used in a few tests. The phosphorus content of the pig iron was 1.84%, as the average of 173 heats made in the course of production; against this the first steel samples showed 0.060%P with an average carbon content of 0.42%. Despite the considerable energy consumption in dephosphorization, the melting load (7.50 tons/h) is about 32% higher than for the all-scrap heats quoted for comparison. It should also be noted that the scrap heats were subject to special observation as test heats, and the results achieved were thus even better than could be expected in the course of normal production. The energy consumption to melt-down at 384kWh/ton, is 23% lower than with an all-scrap charge. The three heats with low-phosphorus pig iron in the charge show even better results.

In the tabulated results obtained in the 40-ton arc furnace groups (4-7), the average values for 82 successive

Group No.	No. of Heats	Furnace	Metal charge, Kg	Pig-Iron proportion, %	Pig-Iron Analysis, % C	Si	Mn	P	S	Steel Analysis, % (1st Sample) C	Mn	P	S	Switch-on to 1st Sample: Time Min	Output rate, t_E/hr.	Energy kWh/t_E
1	10	12 t	11,515	0	—	—	—	—	—	0.34	0.26	0.047	0.046	125	5.6	474
2	3	12 t	14,740	51.5 low-phosphorus	3.92	1.44	0.87	0.085	0.035	0.57	0.11	0.057	0.043	110	8.1	340
3	173	12 t	13,880	48.1 high-phosphorus	3.56	0.55	0.64	1.840	0.041	0.42	0.19	0.060	0.028	112	7.5	384
4	155	40 t	40,900	0	—	—	—	—	—	0.31	0.33	0.049	0.061	97	25.2	456
5	82	40 t	40,656	47.1 low-phosphorus	3.44	0.69	0.50	0.111	0.051	0.38	0.14	0.036	0.052	70	34.7	328
6	41	40 t	40,257	46.8 high-phosphorus	3.33	0.79	0.38	1.370	0.055	0.32	0.16	0.037	0.040	74	33.1	348
7	12	40 t	36,900	49.4 low-phosphorus	3.63	0.72	0.63	0.125	0.047	0.22	0.18	0.021	0.041	54	41.0	344

t_E = tons charged

Table III. Charge data up to first sampling, 12- and 40-ton electric arc furnaces.

Melting charge composition	Charge wt., tons	Hearth Dia., mm	Transformer rating, kVA	Maximum melt-down voltage, V	Melting rate, ton/hr	Remark
100% solid	12.5	3,800	5,000	220	6.6	E. Pakul a
100% solid	11.5	3,200	3,500	200	5.6	von Roll
50% liquid pig-iron low P	14.7	3,200	3,500	200	8.1	von Roll
50% liquid pig-iron high P	13.9	3,200	3,500	200	7.5	von Roll
100% solid	35.0	5,200	9,000	270	11.5	E. Paku la
100% solid	73.0	5,700	15,000	340	17.9	E. Paku la
100% solid	40.9	5,200	18,000	370	25.2	von Rol
50% liquid pig-iron low P	36.9	5,200	18,000	370	41.0	von Rol
50% liquid pig-iron high P	40.3	5,200	18,000	370	33.1	von Rol

Table IV. Furnace data, charging with 100% solid charge, and 50% liquid pig-iron charge.

heats with low-phosphorus and 41 with high-phosphorus pig iron are again compared with results from all-scrap operation. The carbon and phosphorus contents of the first samples varied little. Against the 100% scrap heats, a reduction of about 29% in energy consumption is obtained when charging 50% liquid low-phosphorus pig iron and about 23% with high-phosphorus pig iron. The melting rate is correspondingly 37% and 32% higher.

Table IV gives the hearth diameters, charge weights, transformer capacities, and maximum melt-down voltage for the arc furnaces at Gerlafingen, and the melting rates achieved with 100% solid charge and with 50% liquid pig-iron charge, compared with the values published by Pakulla for various arc furnaces. Bearing in mind the differences in charge weight and the different transformer capacities, the melting rates achieved for 100% solid charges in the 12-ton arc furnace are more or less comparable. The decisive influence of transformer capacity can be seen in the example of the 40-ton furnace. With a transformer capacity of 18,000kVA and a charge weight of about 41 tons, a melting rate of 25.2 tons/h was achieved at Gerlafingen on 100% scrap charges, whereas Pakulla quotes only 17.9 tons/h for a furnace with larger hearth diameter and a 73-ton charge, but with a lower transformer rating of 15,000kVA. Thus the melting rates reached with 50% liquid pig iron in the 40-ton furnace (18,000kVA), i.e., 41.0 tons/h for low-phosphorus pig iron and 33.1 tons/h with high-phosphorus, are as much as 138% and 86% higher respectively than quoted by Pakulla for the 70-ton furnace equipped with a less powerful transformer (15,000kVA) working on all scrap.

Figures 1 and 2 show the course of heats in the 40-ton arc furnace charged respectively with low- and high-phosphorus pig iron. The initial compositions plotted on the vertical axis refer to the average charge compositions (pig iron and scrap). The carbon burn-off curves were drawn to approximate the actual course of refining. Tables V and VI give the material balances for the two heats shown in Figs. 1 and 2.

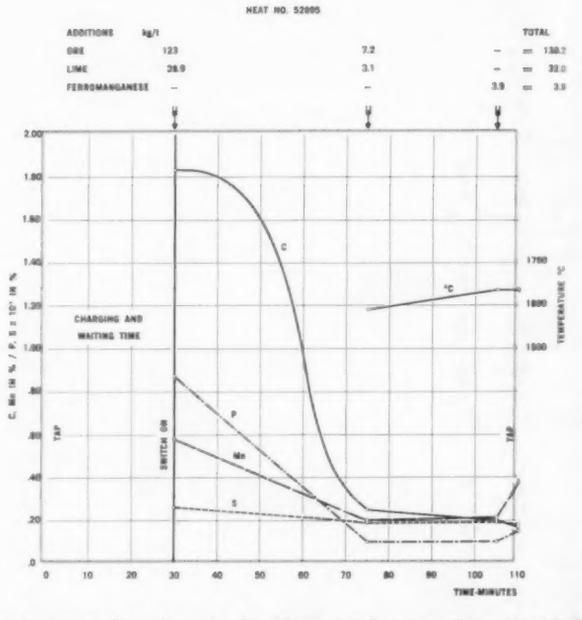

Figure 1. Curves for a heat in the 40-ton arc furnace, charged with 50% low-phosphorus liquid pig iron.

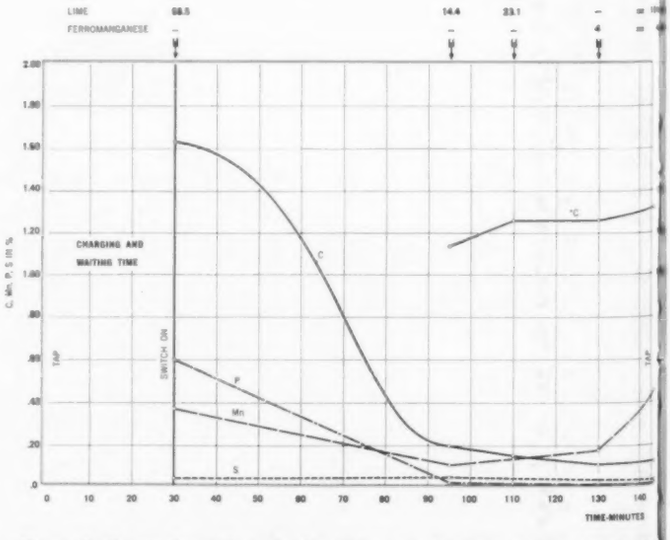

Figure 2. Curves for a heat in the 40-ton arc furnace, charged with 50% high-phosphorus liquid pig iron.

	Total charge, kg	Molten yield, kg/ton	Metal charged (scrap + pig), %	Total metal content (scrap + pig + Fe from ore + FeMn), %
Charge				
Scrap	17,000	491.5	50.0	45.7
Liquid pig iron	17,000	491.5	50.0	45.7
Total metal charged	34,000	983.0	100.0	91.4
Fe from 4,500 kg ore (68% Fe)	3,065	88.5	9.0	8.2
Ferromanganese	135	3.9	0.4	0.4
Total metal content of charge	37,200	1,075.4	109.4	100.0
Lime	1,110	32.0	3.3	3.0
Yield				
Molten steel	34,600	1,000.0	101.8	93.0
Burn-off	2,600	75.4	7.6	7.0
Total	37,200	1,075.4	109.4	100.0

Table V. Charge data for a 40-ton arc furnace heat with 50% liquid low-P pig iron in the charge (Heat No. 52895).

	Total charge, kg	Molten yield, kg/ton	Metal charged (scrap + pig), %	Total metal content (scrap + pig + Fe from ore + FeMn), %
Charge				
Scrap	19,500	518.0	52.3	47.7
Liquid pig iron	17,800	474.0	47.7	43.6
Total metal charged	37,300	992.0	100.0	91.3
Fe from 5200 kg ore (65% Fe)	3,370	89.6	9.0	8.3
Ferromanganese	150	4.0	0.4	0.4
Total metal content of charge	40,820	1,085.6	109.4	100.0
Lime	3,910	104.0	10.5	9.6
Yield				
Molten steel	37,600	1,000.0	100.8	92.0
Burn-off	3,220	85.6	8.6	8.0
Total	40,820	1,085.6	109.4	100.0

Table VI. Charge data for a 40-ton arc furnace heat with 50% liquid high-P pig iron in the charge (Heat No. 51494).

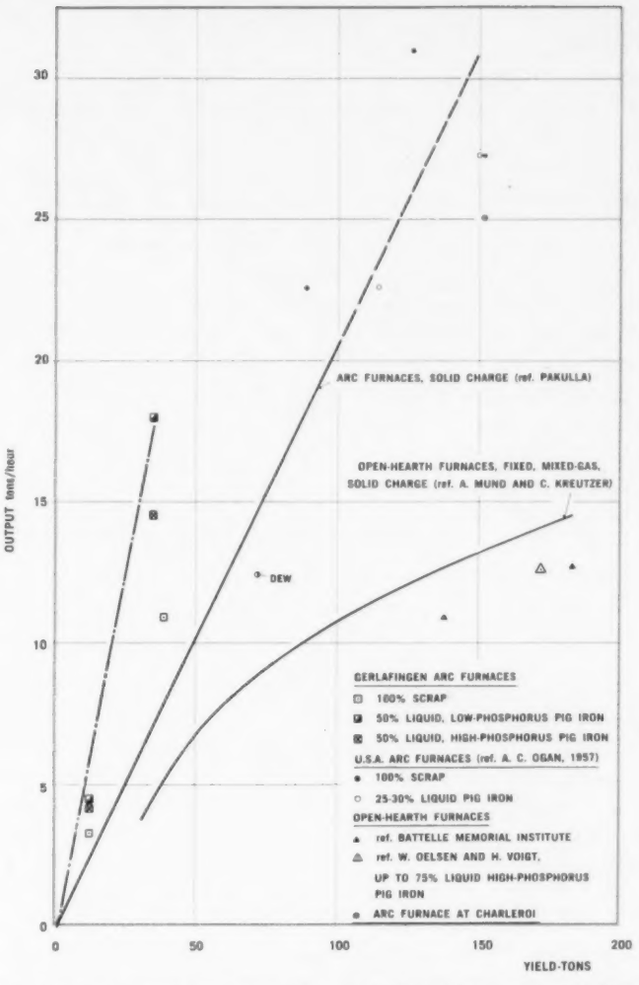

Fig. 3. Hourly outputs for arc furnaces charging 100% scrap and large proportions of liquid pig iron, compared with fixed O H furnaces.

The decisive factor in the increased output for charges with high proportions of liquid pig iron is mainly the shortened melt-down time to the first sample. The finishing of the heat proceeds in the normal manner for the arc furnace, regardless of the type of charge. When liquid pig iron is charged, lively boiling takes place during the melt-down, associated with extensive dephosphorization and desulphurization, so that the finishing time can also be curtailed without deleterious effects on steel quality.

With this increase in output is associated a notable reduction in energy consumption, namely about 17% for heats with high-phosphorus pig iron in the charge and about 21% in the case of low-phosphorus pig iron. These energy consumption figures, like those for hourly output, refer to the molten steel yield.

Fig. 3 shows the hourly outputs for arc and O H furnaces, as a function of furnace size (yield in tons). In this figure the values published by Pakulla, based on output figures from arc furnaces at Deutsche Edelstahlwerke and on data from the Battelle Memorial Institute Report, are amplified by our own test results and by more recent data on large arc furnaces and O H furnaces operating on the pig iron plus ore technique. The hourly outputs for the 40-ton arc furnace operating with about 50% liquid pig iron are higher than for the 200-ton O H furnace and roughly correspond to the good results on 70-ton arc furnaces operating on 100% solid charge.

The consumption of *refining ore* depends largely on the pig iron composition, the desired final carbon content, and (by no means least) the oxygen content of the ore itself. If a rich hematite ore is used, one can estimate at about 220-290 kg ore per ton of pig iron. Using magnetite ore, the ore consumption is correspondingly higher. The degree of oxidation of the scrap can greatly influence the ore consumption.

The iron pickup from the ore depends on the proportion of pig iron in the charge and the ore required per ton of pig iron. With pig-iron proportions of about 50-70%, the iron pickup was between 8 and 12% of the weight of metal charged.

The yield of metal was closely observed during the series of tests. Taking into account the iron contained in the ore, the molten metal yield averaged between 92 and 94%. Referred to the metallic charge alone (pig iron and scrap) this gave a yield of about 101-103%, corresponding to an iron pickup from the ore of about 9%.

The lime consumption is greatly influenced by the pig iron composition. Melts with pig iron low in phosphorus and silicon content under 1.0% required an average 32 kg/ton of steel. When the pig iron contained more silicon and more desulphurization was required, the lime requirement rose to over 50 kg/ton of steel.

All data in this article are expressed in metric units.

Metallurgical Considerations

Carbon

The carbon burn-off rate, which has a decisive influence on the duration of the heat, is determined by the quantity of oxygen introduced per unit of time. However, since the reaction between the ore and the carbon is strongly endothermic, the carbon burn-off rate in the presence of sufficient ore becomes a function of the electrical energy supplied per unit of time.

When, as in the examples quoted, the refining time is kept below 1hr. with about 50% liquid pig iron in the charge, the mean carbon burn-off rate can be reckoned at about 2% C/h. Considering only the pig iron in the charge, this corresponds to a mean carbon burn-off rate, for the pig iron of about 3%C/h. In Figs. 1 and 2 it was shown that carbon burn-off does not proceed uniformly during the refining period. In the first 10-15 min it is relatively low, reaching its maximum during the next 25-30 min and falling off again towards the end of refining. Roughly 75% of the carbon is oxidized within about 25 min. In this period one must assume a mean carbon burn-off rate of about 3%C/h, referred to the total charge, and a true rate of about 6%C/h for the pig iron.

When carbon is oxidized, considerable volumes of carbon monoxide are formed. For the types of charge described, and with the carbon burn-off rate held high, it was necessary to reckon with the evolution of about 0.5 m^3/s (NTP) of CO during the main refining period. The gas issuing from the furnace during this period contained about 70-80% CO.

Phosphorus

When high-phosphorus pig iron is charged in the arc furnace, dephosphorization becomes of decisive importance. An example of dephosphorization, in comparison to that of carbon burn-off, has already been given in the discussion of the principles underlying the technique. Although the pig iron contained 1.77%P, at 0.92%C in the bath, dephosphorization had already proceeded to 0.030%, with the slag loaded up to 15%P_2O_5. Thus under these working conditions, dephosphorization can be made largely to precede carbon burn-off.

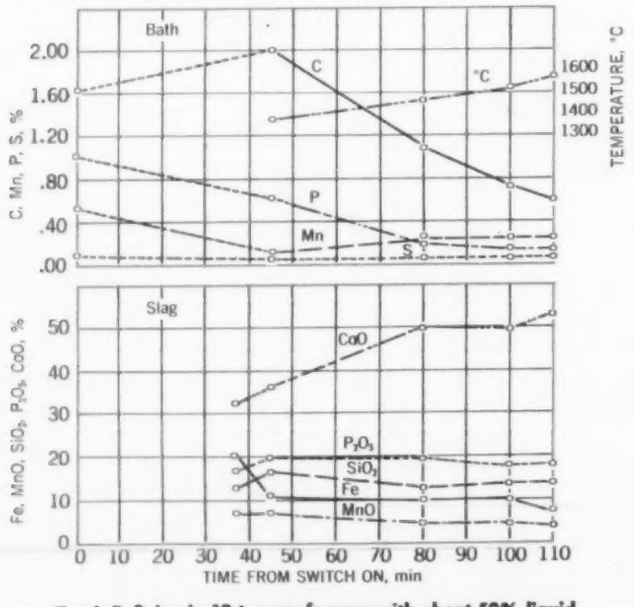

Fig. 4. Refining in 12-ton arc furnace with about 50% liquid high-phosphorus pig iron in the charge. Charge No. 54988.

Figure 4 shows the burn-off of the accompanying elements in the pig iron, in detail, together with the changes in slag composition during the refining period. With a charge containing about 50% pig iron of phosphorus content 1.96%, the amount of lime used was 13.7% of the weight of pig iron. At the end of the refining period the slag contained 17.40% P_2O_5 and 6.41%Fe, and the bath 0.58%C and 0.100%P. The bath temperature was 1565° C.

Table III gives the mean compositions of the pig iron and of the first steel samples for 173 heats in the 12-ton furnace and 41 heats in the 40-ton furnace. When these are compared with corresponding samples for heats made with low-phosphorus pig iron and with 100% scrap, it can be seen that, in spite of the high phosphorus content of the pig iron, that of the steel is at about the same low level. Bearing in mind the short refining period and the low energy consumption, this result is very satisfactory.

With increasing free lime content or decreasing P_2O_5 content in the slag, definitely lower phosphorus contents were found in the steel. Better dephosphorization was obtainable in the 40-ton arc furnace for comparable free lime contents in the slag. Apparently the higher specific transformer capacity has a favorable influence here, causing more intense and more uniform reaction between slag and bath.

The slags rich in P_2O_5 were normally removed after the first sample to eliminate the remaining carbon after replacing with a second highly basic slag and to finish the heat in the normal way. This also facilitates further dephosphorization down to very low levels. The composition of the first phosphorus-rich slag suggests that it may find use as a fertilizer. Investigations of the citric acid solubility of these slags are in progress.

Figure 5 shows the frequency distribution curve for the final phosphorus contents reached in the finished steel (tap samples), for 144 successive heats. In spite of the high phosphorus content in the pig iron, namely 1.8%, over 75% of all heats contained less than 0.030%P. In the few heats with higher phosphorus contents the slag was not removed adequately, so that the increased P_2O_5 in the finishing slag led to ready phosphorus reversion as the temperature was raised. In the 40-ton furnace similar results were attained.

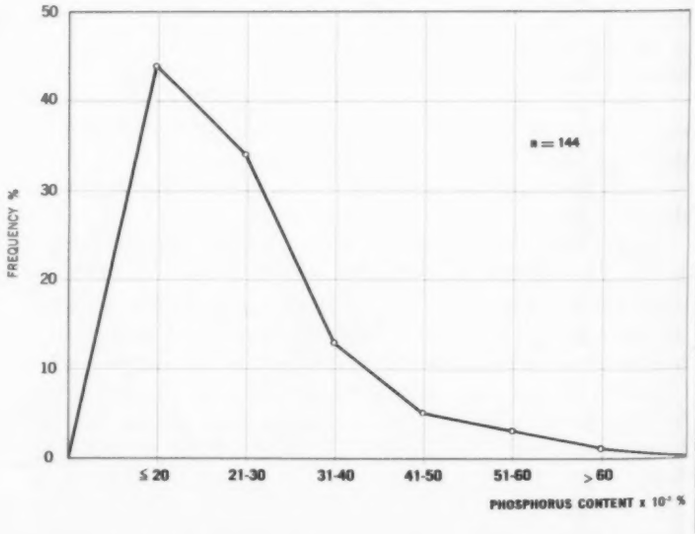

Fig. 5. Frequency distribution curve of phosphorus content of the finished steel from 144 heats under continuous production conditions with about 50% liquid high-phosphorus pig iron.

Sulphur

Desulphurization in the arc furnace causes no particular problems. When high-phosphorus pig iron was charged, however, desulphurization during the refining period was found to be clearly superior to the case when low-phosphorus pig iron was charged. The samples come from three test series with high-phosphorus pig iron and different amounts of lime in the charge. The differences in mean free lime content of the slags compare as follows:

Test series	*Furnace capacity, tons*	*Free lime content, %(CaO)'*
A	12	23.55
B	12	17.90
C	40	12.98

In group A, with the highest mean free lime content, were found the highest partition coefficients and the lowest sulphur contents for the steel.

Using highly basic finishing slags practically any sulphur limit requirement can be met in the arc furnace. In the majority of the heats it was possible to get below 0.020%S, despite the relatively high sulphur contents of pig iron and scrap. In the 40-ton arc furnace, a considerably lower slag basicity was used experimentally, so that somewhat higher sulphur contents had to be expected in the steel.

Nitrogen

In about 70% of the heats, values of 0.004%N or less were obtained. Tests carried out later have shown that values of 0.002-0.003%N can be maintained for unkilled mild steels, and 0.004%N for killed steels.

Experiments on Direct Steelmaking by Additional Smelting of Ore Fines with Coke Fines

From the point of view of material costs, the gain in iron from the ore can have considerable economic importance. The iron in the ore is converted directly into steel ready to pour. Durrer pointed out years ago that the pig iron plus ore process is the only one used on a truly industrial scale in which iron in the ore is converted in one operation to finished steel.

Following Durrer's line of thought, further tests were carried out in which more ore was added to the charge than required to refine the pig iron, and the extra ore reduced using additional solid carbon, e.g., coke fines, in the arc furnace.

In tests in the 12-ton and 40-ton furnaces it was possible in this way to obtain an iron gain in the form of finished steel, amounting to more than one-third of the original metallic charge. Thus the molten-steel yield in terms of pig iron and scrap charged could be raised to more than 130%.

As an example of the economic possibilities of such a technique, data are given on a heat made in the 40-ton furnace. Table VII shows the material balance for a heat in which additional iron to the amount of 23.1% of the weight of metal (pig iron and scrap) charged was obtained from ore and converted directly to steel. The

	Total charge, kg	Metal yield, kg/ton	Pig iron + scrap charged, %	Total metal content (scrap + pig + Fe from ore + FeMn), %
Charge				
Scrap	15,500	445.0	50.3	40.6
Liquid pig iron	15,300	438.0	49.7	40.1
Total metal charged	30,800	883.0	100.0	80.7
Fe from 10,000 kg ore (68% Fe)	7,130	204.4	23.1	18.7
Ferromanganese	230	6.6	0.8	0.6
Total metal content of charge	38,160	1,094.0	123.9	100.0
Lime	1,400	40.2	4.6	3.7
Coke fines	1,900	54.5	6.2	5.0
Yield				
Molten steel	34,880	1,000.0	113.3	91.4
Burn-off	3,280	94.0	10.6	8.6
Total	38,160	1,094.0	123.9	100.0

Table VII. Material balance for a 40-ton arc furnace heat with additional smelting of ore fines and coke fines, Heat No. 52597, 23.1% Fe gain from ore.

yield in terms of the total metal content of the charge was 91.4%; it can thus be assumed that practically all the ore had been reduced and only the natural losses have occurred.

In spite of the relatively extensive reduction required, the entire melting time from tap to tap was only 160 min. In comparison with the 100% scrap technique, roughly the same hourly output was attained despite the extensive reduction, but the energy consumption was increased by about 15-20%.

Since in this type of heat three processes, namely scrap melting, pig iron refining, and ore reduction by the additional solid carbon charged, are taking place side by side, it is difficult to find the true energy consumption for these three heat-consuming processes. An estimate of the heat consumed in melting the scrap and in refining the pig iron, on the basis of known consumption figures, suggests that one can reckon on requiring less than 2,000kWh/ton for the energy to convert the ore directly to steel; in other words, less energy is needed than in the production of pig iron in the electric smelting furnace.

Input records for the 40-ton furnace show that with a charge consisting entirely of scrap, the frequent arc extinction leads to pronounced variations in input, whereas both when liquid pig iron is charged, and with additional reduction, the energy input is very steady and the furnace operates completely quietly.

Summary and Conclusions

Full-scale tests have been carried out in 12-ton and 40-ton arc furnaces in which the charges contained large proportions of liquid pig iron and ore was used as refining agent. The principle of the technique has been discussed and the progress of melting described and illustrated. Tests have shown that the refining reaction can be controlled despite the high refining rate.

Under continuous production conditions, both low-phosphorus and high-phosphorus qualities of pig iron have been used in the charge. In both cases a considerable increase in the hourly output together with a reduction in energy consumption have been recorded. In the 40-ton arc furnace it was possible to reach hourly outputs of up to about 15 tons/h with charges containing about 50% liquid high-phosphorus pig iron, and exceeding 18 tons/h with low-phosphorus, corresponding to an increase in output of 30% and 60% respectively, as against normal operation of the furnaces with 100% scrap charges. The energy consumption for the majority of heats was less than 500kWh/ton of liquid steel.

Rich ore fines were particularly well suited as refining ores. With about 50% pig iron in the charge, one could expect a gain of about 8-10% of the charge weight from the ore. The metallic yield, referred to the metallic charge of pig iron and scrap, thus rose to more than 100%. The life of the furnace refractories was roughly as good as with 100% scrap charges. Durability figures of 137-163 heats were obtained for the walls and over 100 heats for the r oo The electrode consumption was about 5 kg/ton. H gh phosphorus pig iron could be dephosphorized to low le vel without notably extending the refining time. The F_2O contents of better than 15% reached in the slag sug ges that it can be used as a fertilizer.

Finally, it is shown in one example that the proportio of steel obtained directly from ore can be considerabl increased by the additional reduction of ore fines wit coke fines. Within the limits of the tests so far carried ou up to one-third of the weight of steel can be obtaine directly from ore. The majority of tests were carried ou with about 50% pig iron in the charge. When the pig-iro content was raised to about 70% roughly the same result were obtained.

The problem which originally formed the basis of th work, namely the economic conversion of high-phosphoru pig iron to steel in the arc furnace, can be regarded a solved, at least as far as conditions in Switzerland ar concerned. With the increasing expansion of electric stee making, the problem of refining pig iron in the arc furnac has recently gained steadily in importance in othe countries also. The present results will therefore be o wider interest than to the Swiss industry alone. If th authors' views are correct, arc furnaces will gain in com petitive importance by the possibility of handling pi iron to the same extent as in O H furnaces.

Literature References

Comparative economics of open-hearth and electric furnaces for production of low-carbon steel. Report prepared by S. L. Case, D. D. Moore, C. E. Sims and R. I. Lund, Publ. by Bituminous Coal Research, Inc., Pittsburgh, Pa., 1953.

Krebs, E. and Pakulla, E.: Stahl und Eisen 75 (1955), Pages 9/24 (Stahlw.-Aussch. 569).

McQuaid, H. W.: Iron Age 164 (1949), No. 23, Pages 86/92. — **Iron Steel Engr.** 29 (1952), No. 12, Pages 139/140, 142, 145 and 147.

Wilbanks, I. E.: J. Metals 5 (1953), Page 627.

Reinartz, L. F. and Barnes, H. C.: Iron Steel Engr. 31 (1954), No. 1, Pages 114/119.

Durrer, R.: Die Metallurgie des Eisens (1942) Berlin, Page 446, Verlag Chemie.

Howard, I. C.: J. Iron Steel Inst. 173 (1953), Pages 285/291; 174 (1953), Pages 251/259.

Robiette, A. G.: Iron Coal Trades Rev. 167 (1953), Pages 1231/1236.

Lafon, I. E.: Metall. et Constr. mec. 86 (1954), Pages 119, 121/123 and 125.

Pakulla, E.: Stahl und Eisen 77 (1957), Pages 197/204.

Stassin, G.: Vortrag auf dem Internationalen Eisenhüttentag in Lüttich, June 1958.

Ogan, A. C. and Carney, D. I.: J. Iron Steel Inst., 178 (1958), Pages 307/314.

Oelsen, W. and Voigt, H.: Stahl und Eisen 75 (1955), Pages 1013/1024.

Durrer, R.: Verhütten von Eisenerzen (1954) Düsseldorf, Pages 730/739, Verlag Stahleisen.

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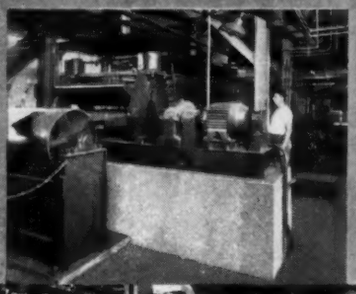

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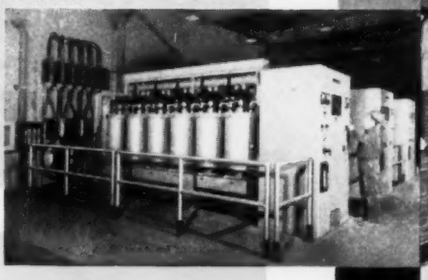

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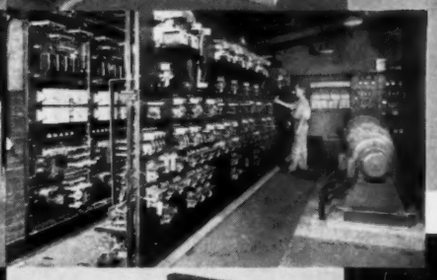

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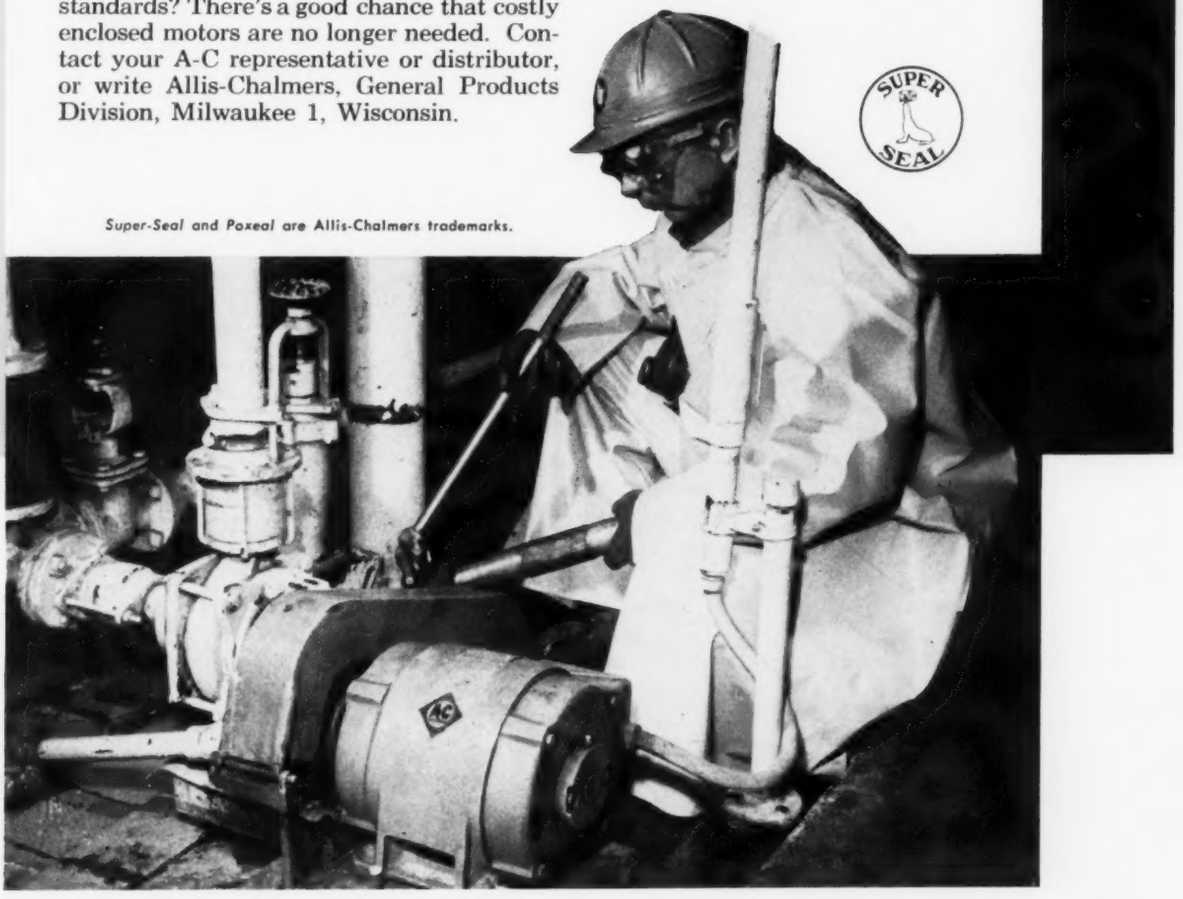

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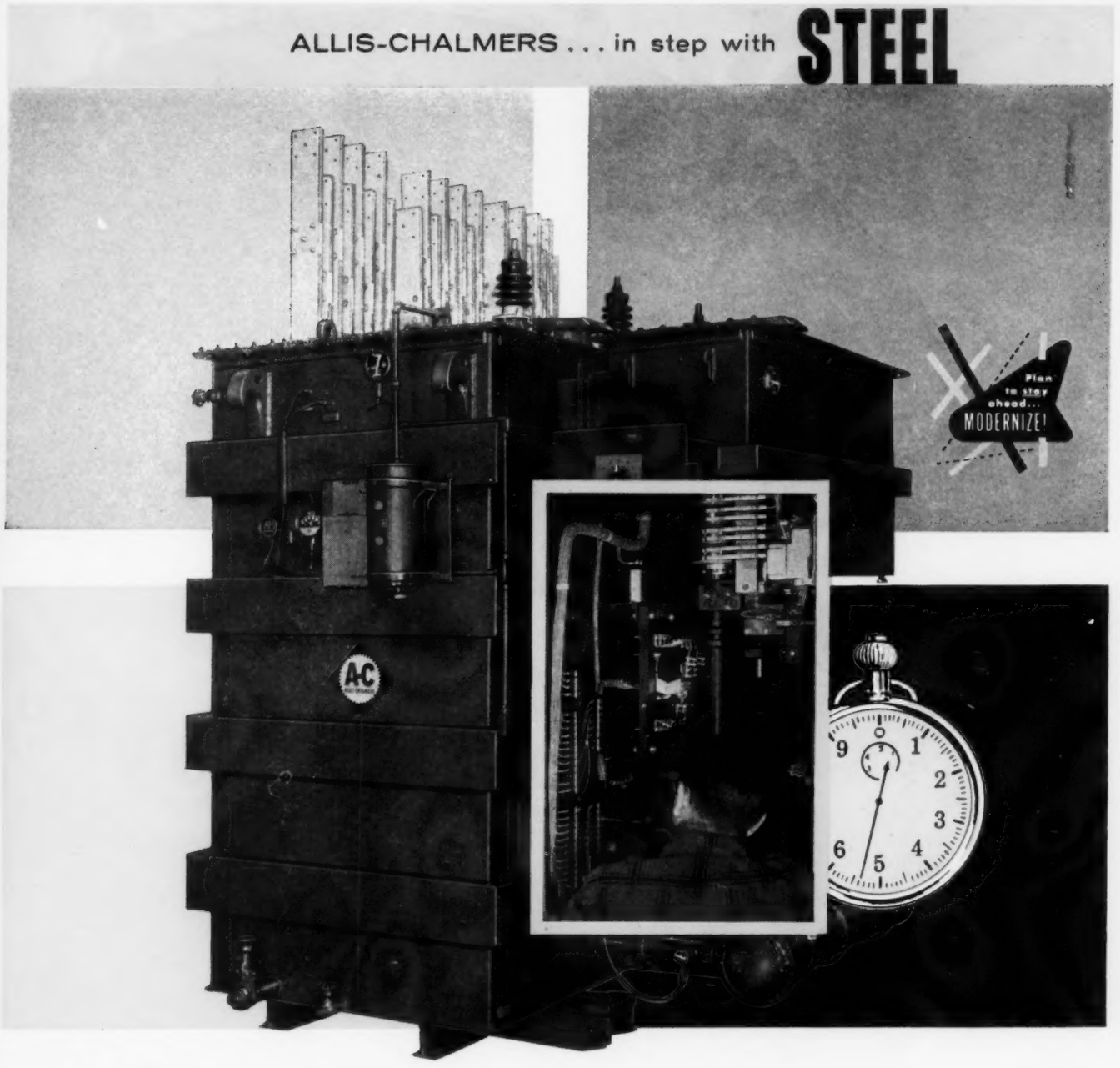

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Let's get down to cases on *your* oxygen needs. Write, call or wire Department IM, Air Products, Inc., Allentown, Pa. Phone: EXpress 5-3311.

Air Products
...INCORPORATED

a brand new A-c. motor

the DUTY MASTER

A completely new motor produced by The Reliance Electric and Engineering Company and its Master Electric Division. Duty Master offers built-in protection, simplified lubrication and improved performance.

Duty Master shows that all motors are not alike, see next page for details.

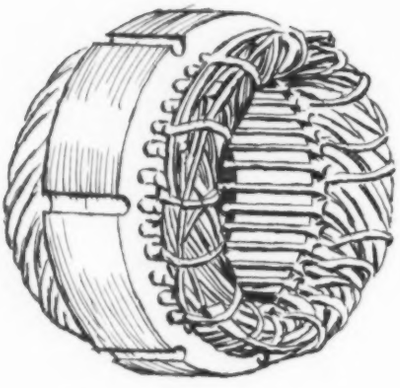
Available now from stock, 1 thru 250 hp. in all enclosures.

RELIANCE ELECTRIC AND ENGINEERING COMPANY

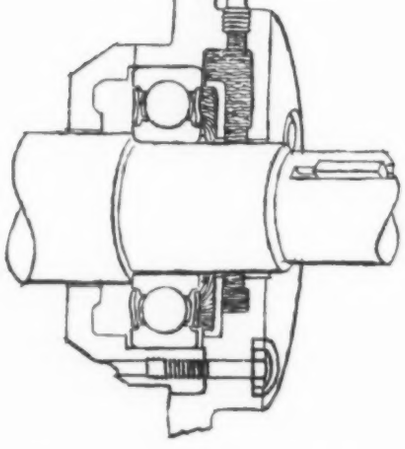
MASTER ELECTRIC COMPANY DIVISION

Earl C. Barnes, Chief Engineer

"Duty Master is built to last from the inside out."



PROTECTED WINDINGS



METERMATIC LUBRICATION

"Built-in protection was the aim in designing the Duty Master. From the steel core to the cast iron frame, everything possible has been done to insure long life under severe operating conditions.

"The insulation is moisture-proof and acid-resistant. Windings are thoroughly dried, pre-heated and impregnated with multiple dips in thermosetting varnish, and finally given a sealing coat of finishing enamel.

" 'Metermatic' bearing lubrication fits any plant lubrication schedule. Motor bearings are lubricated constantly from a large reservoir. A metering plate feeds measured amounts of grease to the bearing as required. The reservoir and automatic grease relief along the shaft make it impossible to over or under grease the Duty Master.

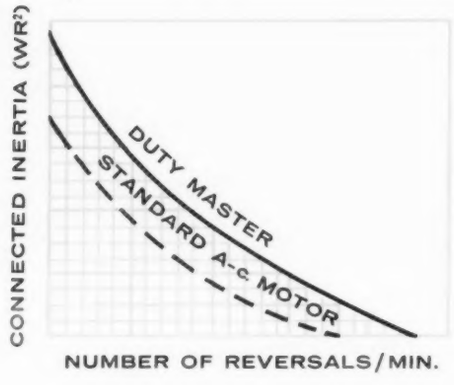
"Whatever your requirements, Duty Master gives you extra built-in protection and longer motor life." *Earl C. Barnes*

RELIANCE — Duty Master A-C. MOTOR

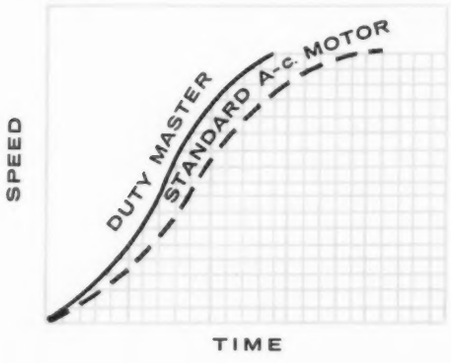
Dr. C. G. Veinott, Chief A-c. Design Engineer

"Duty Master's electrical design provides improved operating characteristics."

REVERSAL



ACCELERATION



"The electrical design of the Duty Master was thoroughly analyzed through the use of digital computors. The purpose of this specialized work was to produce a motor with maximum operating characteristics and maximum efficiency.

"The most visible result of the extensive computor program is the new low inertia rotor. The rotor, like the rest of the Duty Master, takes advantage of new materials and techniques. This rotor, plus better ventilation and other refinements, gives a definite improvement in acceleration, reversals and start-stop performance.

"This is just one example of many mechanical and electrical design changes that make Duty Master a new motor, not just a face lifting." *Dr. C. G. Veinott*

RELIANCE — **Duty Master**
A-C. MOTOR

John Walker, Manufacturing Manager

"Manufacturing quality and deliveries are emphasized for Duty Master."

"A motor design is no better than the finished product. That is why we lay particular emphasis on experienced plant people and top quality materials.

"New automatic winders, annealing furnaces, conveyor systems, turning and welding equipment are another part of the quality picture. Equally important is proper scheduling to deliver the motor on time. The new Duty Master is not only an exceptionally good motor, it is an available motor, ready for delivery without unwarranted delay." *John Walker*

Duty Master Motors, 1 thru 250 hp. in all enclosures, are ready for immediate off the shelf shipment from Reliance Distribution Centers and Warehouses across the country. Contact your Reliance Sales Engineer for complete information, or write today for Bulletin No. B-2106.

RELIANCE ELECTRIC AND ENGINEERING CO.

CLEVELAND 17, OHIO
CANADIAN DIVISION: TORONTO, ONTARIO
Sales Offices and Distributors in Principal Cities

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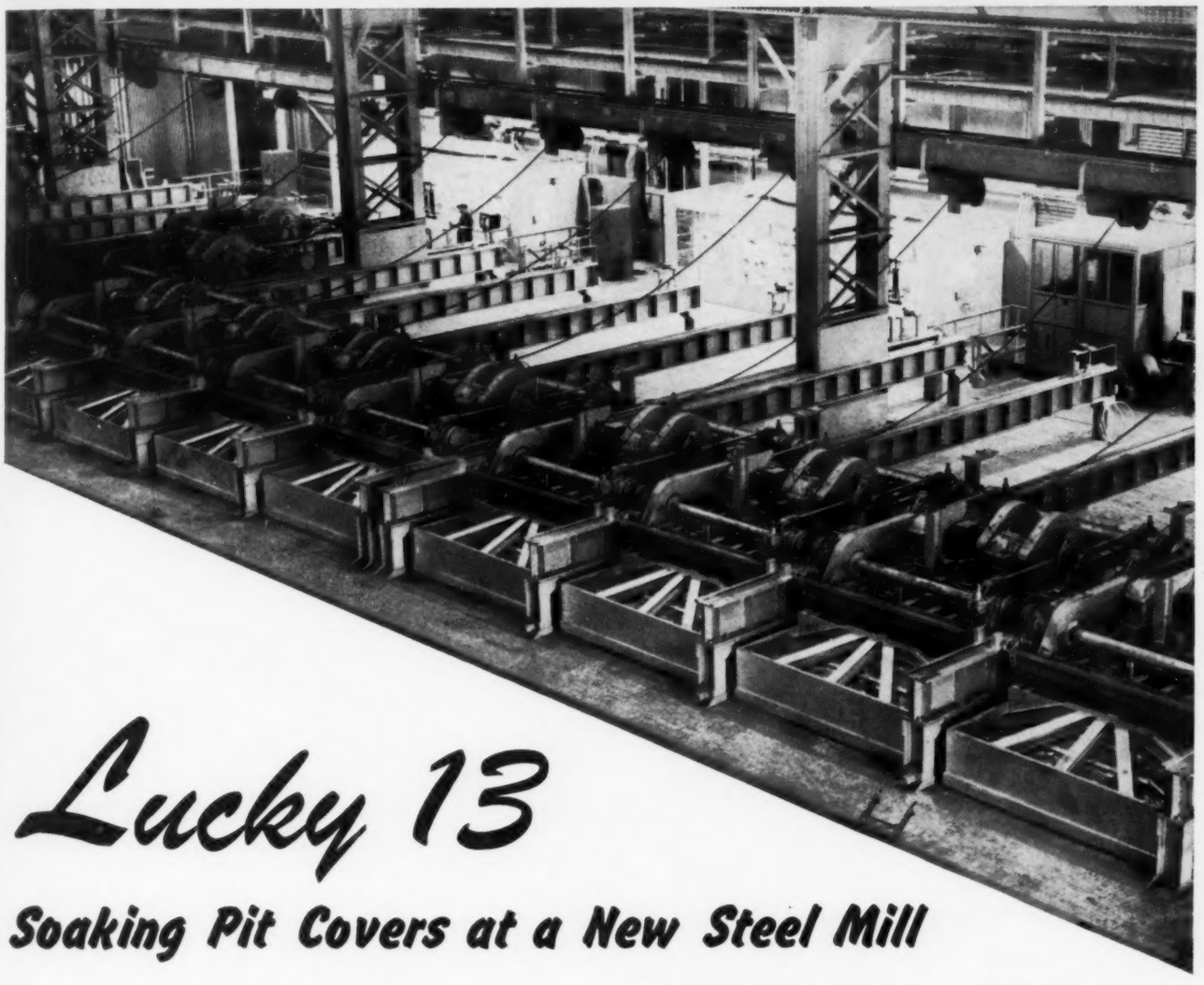

Lucky 13

Soaking Pit Covers at a New Steel Mill

"The best sign of satisfaction is a repeat order — which is the best endorsement."

Ramtite is our business . . . Not a side line!

A well known steel products mill decided to produce its own steel and selected RAMTITE No. 25 for their *thirteen* soaking pit covers.

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RAMTITE No. 25 with its versatility might readily solve some of your refractory problems. Our Sales Engineer in your locality or area can be helpful, if you ask him to call. Or learn more about Ramtite 25 by sending the coupon below. *Remember, Ramtite sees a job through from start to finish—design, construction, installation, working closely with your own engineers, staff and crew.*

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The specially-processed fish oil vehicle in the Rust-Oleum 769 Damp-Proof Red Primer penetrates rust to bare metal – as proved in radioactive tracing studies.

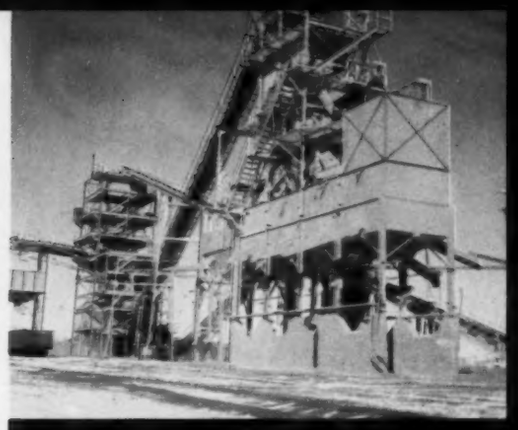
ON RUSTED SURFACES simply apply Rust-Oleum 769 Damp-Proof Red Primer directly over the sound rusted surface after scraping and wirebrushing to remove rust scale and loose rust. You stop present rust, because the *specially-processed* fish oil vehicle in the primer penetrates through the rust to bare metal – driving out air and moisture that cause rust. You save time and money – as costly surface preparations are usually eliminated. It's easier to use, too . . . because the "grease-like" nature of the fish oil vehicle in the primer enables it to slide over the surface and work its way through the rust formations – yet, it dries to a firm, protective, decorative coating that provides a tough, durable base for Rust-Oleum finish colors.

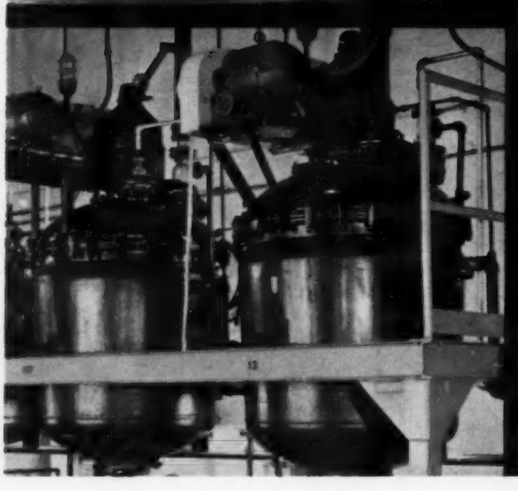
RUST-OLEUM®

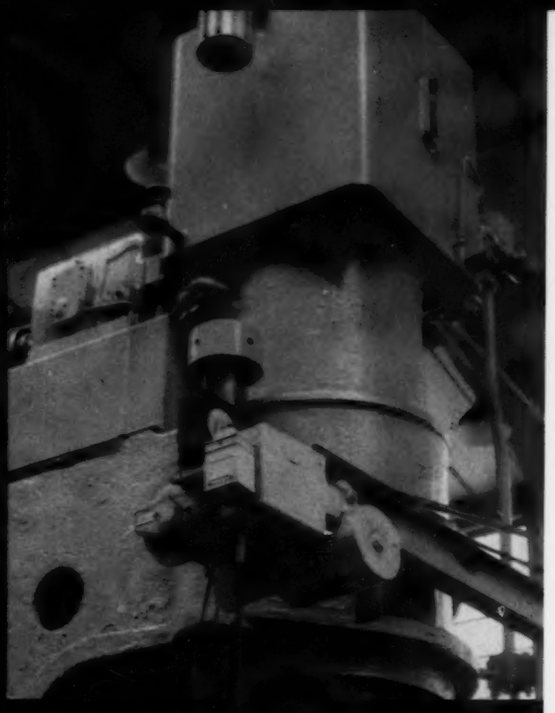
STOPS RUST!®

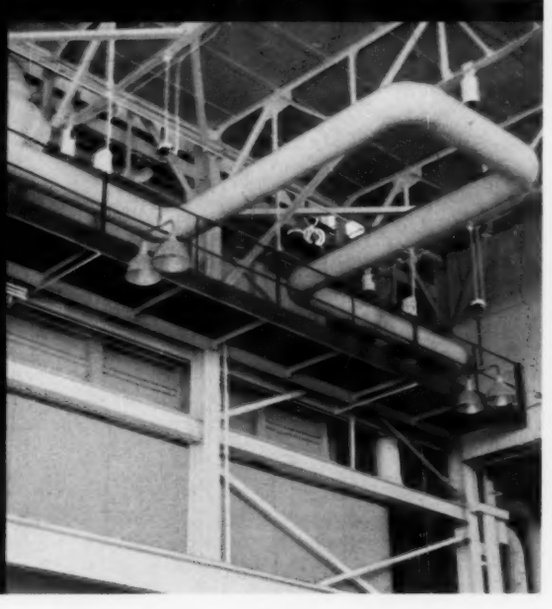
SEE OUR CATALOG IN SWEET'S

What the Rust-Oleum SYSTEM of lasting beauty does for you!









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BRUSH OR SPRAY the Rust-Oleum finish color of your choice over 769 Damp-Proof Red Primer – that's the Rust-Oleum system of colorful, lasting beauty for rusted metal. Previously painted surfaces in good condition normally require only one Rust-Oleum coat. Rust-Oleum top coatings are available in practically ALL COLORS. Many of them are specially formulated to resist heat, chemicals, and other corrosion-producing conditions, while others are formulated to match the original colors on construction, farm, and oil field machinery and equipment. Try Rust-Oleum soon. Prompt delivery, efficient service, and a wealth of rust-stopping experience are yours through your nearby Rust-Oleum Industrial Distributor.

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Please send me the following at no cost or obligation:

- ☐ Free test sample of Rust-Oleum 769 Damp-Proof Red Primer for rusted metal surfaces.
- ☐ Complete literature with applications and color charts.
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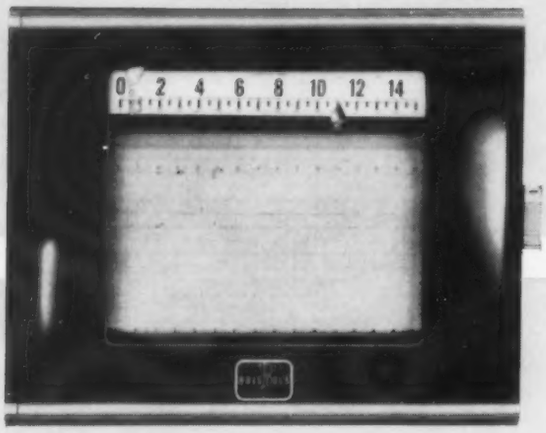
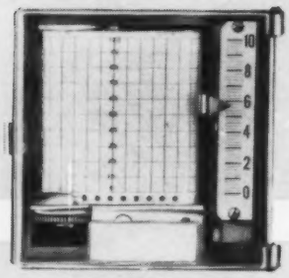
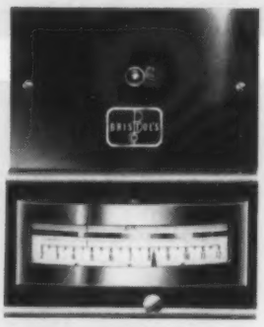
- ☐ Thirty-page report on Rust-Oleum fish oil penetration.



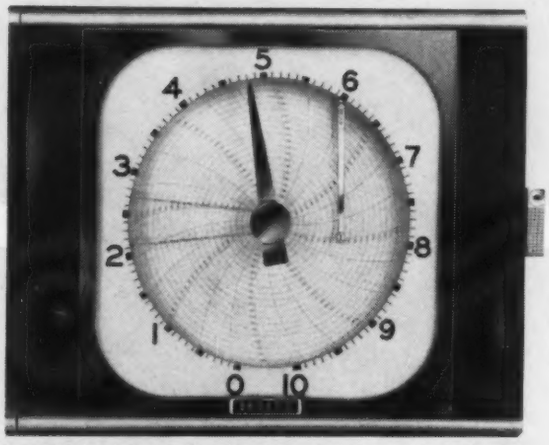
Dynamaster Electronic Potentiometer Pyrometer—Strip-chart model records on chart 11" wide, 120' long.



Miniature Electronic Dynamaster Pyrometer—Records on 3" strip-chart. Indicator model features easy-to-read 9" scale length.



Bristol Millivoltmeter Pyrometers—Free Vane* pyrometer controllers (shown) or indicating types. Many control modes available.



Dynamaster Electronic Potentiometer Pyrometer—Round-chart model records on 12" chart, indicates on extra large scale.

MODERN PYROMETERS...key to profitable use of HEAT

Bristol recording and automatic controlling pyrometers for temperatures up to 5000°F can help you increase product uniformity, cut fuel and maintenance costs

Bristol makes a wide range of pyrometers for every requirement: Electronic potentiometers, millivoltmeter and radiation types . . . for furnaces, ovens . . . every type of heating equipment, every kind of fuel. The reliability and accuracy of these precision instruments have been proved in thousands of installations.

Take just one advanced Bristol instrument, for example, the Electronic Dynamaster* Potentiometer Pyrometer:

CONTINUOUS STANDARDIZATION PLUS ACCURACY OF STANDARD CELL

Continuous standardization in Dynamaster Electronic Pyrometers requires no dry-cells, **but still retains the precision standard cell for highest stability and accuracy of voltage reference.** Results: No interruption to operation, no batteries to change. And here are just a few of the Dynamaster types available:

A model for every requirement: Dynamaster Pyrometers are available as single-pen, two-pen, and multiple-record (up to 24 points) *strip-chart* instruments and as *round-chart* instruments.

Electric and pneumatic controllers: Both strip- and round-chart instruments are made in a very wide variety of controllers that meet every furnace and oven control requirement, including the following in a great many forms:

Electric Control—on-off, proportional input, 3-position, proportioning, proportional with automatic reset, and time-program.

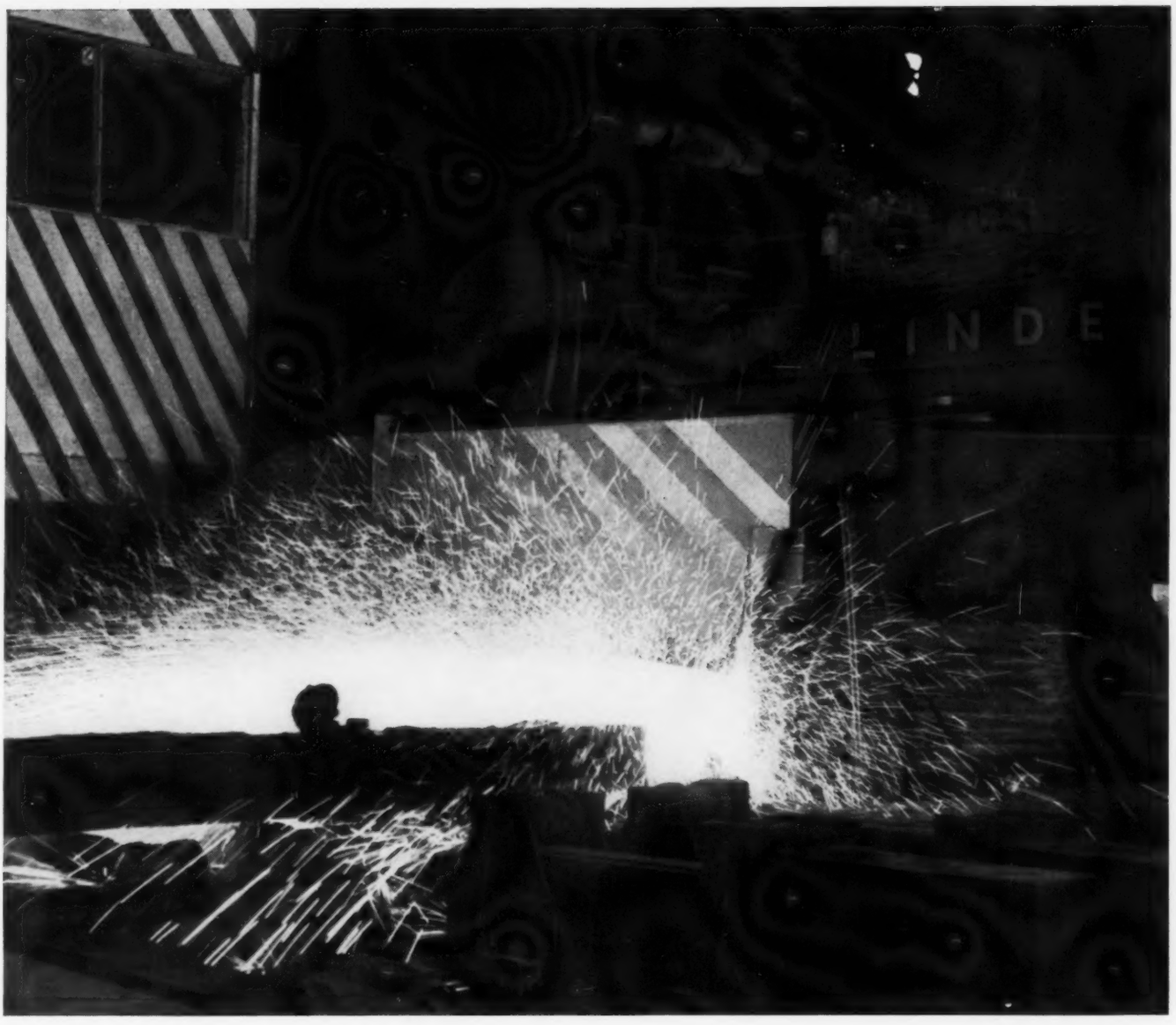
Pneumatic Control—on-off, proportional, and proportional with reset.

Miniature Dynamaster Pyrometer: Full plug-in flexibility . . . takes only 5" x 5⅛" of panel space, but has same basic accuracy, same time-tested operating principle as full-size Dynamaster pyrometers described above. Ideal for graphic panels and centralized recording or indicating of large numbers of variables. Either electrical or pneumatic control types available.

Write for complete data on Bristol Pyrometers—and remember Bristol offers a complete line of thermocouples and pyrometer accessories. The Bristol Company, 123 Bristol Road, Waterbury 20, Conn. **T.M. Reg. U.S. Pat. Off.* 9.9

BRISTOL... for improved production through measurement and control

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS



LIN-DE-SURFACER MACHINE HOT-SCARFS 4.27 MILLION TONS IN 27 MONTHS

Weirton Steel Company, Division of National Steel Corporation, set the record. Of the 65 *Lin-de-Surfacer* machines serving steel plants throughout the world today, this is the champ—4.27 million tons in just 27 months.

Mechanized scarfing is the fastest, most economical way to upgrade surface quality. Your costs depend on your production because you lease the *Lin-de-Surfacer* machine on the basis of the tonnage it processes. It can be rolled on or off the production line in seconds. Scarfing speeds can reach 195 ft./min.

And—most important—savings over hand-conditioning methods are estimated conservatively at $1.50 per ton—are often much higher.

Linde Company—a leader in the production and distribution of oxygen and acetylene—pioneered the development of mechanized scarfing. To find out how hot-scarfing can help your operations, call the nearest Linde office. Or write Linde Company, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N.Y. In Canada: Linde Company, Division of Union Carbide Canada Limited.

Linde TRADE-MARK

UNION CARBIDE

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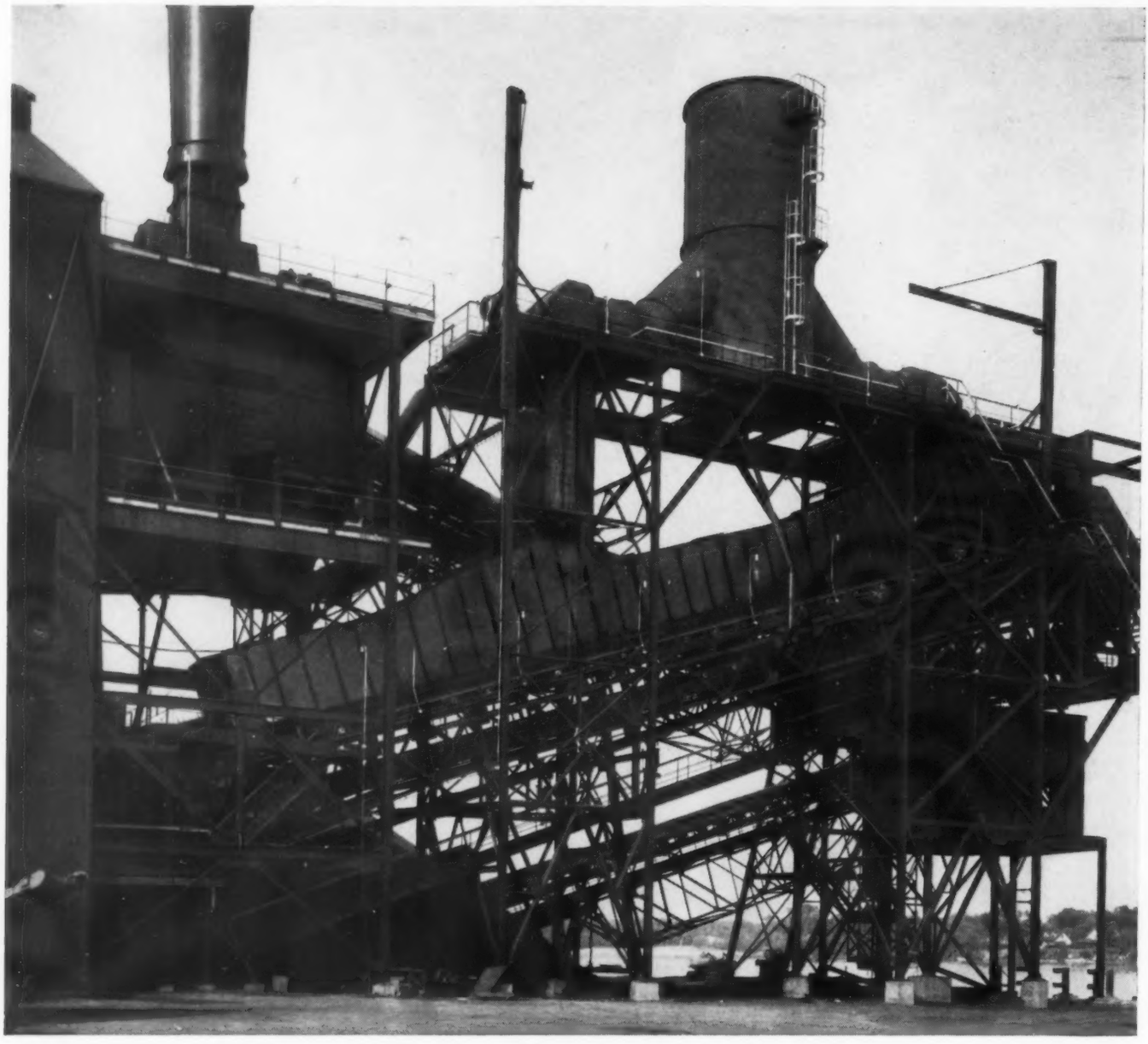

sinter air-cooled and elevated at same time . . .

DRAVO-LURGI STRAIGHT LINE COOLER

Utilizing the air-cooling principle which delivers more *usable* tonnage, the Dravo-Lurgi straight line cooler raises sinter at the discharge end for storage in bins or for conveying. Output is increased by reduction of shattering and dust.

Where space permits its installation, the straight line design provides an extremely efficient method for both cooling and handling sinter. Here are some of the features which lead to maximum utilization of any sinter machine:

- No water quenching to cause shattering, cracking or brittleness.
- No need for plows or scrapers at the discharge end.
- Sinter is undisturbed during cooling—breakup is minimized.
- Sinter is elevated while cooling, facilitating loading.

A Dravo engineer will be glad to explain how Dravo-Lurgi coolers (either straight line or circular) can increase *usable* tonnage in your sintering operation. Write or phone DRAVO CORPORATION, PITTSBURGH 22, PENNSYLVANIA.

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Foreign Digests

Complete translations from which these condensations were prepared are available from Henry Brutcher, P.O. Box 157, Altadena, Calif., to whom all correspondence should be addressed.

"HEATING PROBLEMS IN INDUSTRIAL-SCALE DEGASSING OF LIQUID STEEL

by H. KNUPPEL, K. BROTZMANN, K. RUTTIGER, and A. DIENER. (Translation No. 4561 from Stahl und Eisen, vol. 79, 1959, No. 5)

△ THE possibilities of subjecting molten steel to any treatment after tapping are limited, particularly by temperature. This is of importance in the degassing of liquid steel between tapping and teeming. Experience shows that a large steel bath surface is required in the degassing vessel and consequently a large degassing vessel is necessary as the melt foams and splashes violently during degassing. Depending on the carbon content, the quantity of gas dissolved in the steel occupies twice to ten times the volume of steel under normal conditions. Under conditions associated with degassing, i.e., high temperature and reduced pressure, the volume of gas liberated can attain even as much as a thousand times the volume of the steel.

If degassing were carried out in an unheated vessel, there would be a considerable thermal loss by radiation and conduction. Under normal operational conditions, such high thermal losses can be counteracted only with difficulty by prior superheating of the melt. The smooth integration of a vacuum treatment in normal steel production is, therefore, closely associated with the possibility of keeping temperature losses during treatment within tolerable limits.

Heating of degassing vessels is necessary to prevent the steel from freezing in the treatment vessel and to reduce the temperature losses of the melt. It is possible either to preheat the vacuum vessel with a low power heater or to heat it only during vacuum treatment with a high power heater. Alternatively both these methods can be applied. If heating is carried out only during vacuum treatment even with high power heating, no more success would be achieved than by preheating the vessel at greatly reduced power. By preheating the vacuum vessel to the temperature of molten steel, the over-all temperature losses will be reduced to approximately the normal ladle losses. Any further effective reduction of these losses can be achieved only by additional heating using very high power during vacuum treatment.

Available heating methods include resistance heating with hairpin elements or bar elements and electric arc heating. Hairpin heating is suitable for up to 300 kw and bar heating, up to 600 kw. A further effective reduction in temperature losses is possible only with electric arc heating. For the purpose of preheating, this must be carried out with relatively less power but for heating during treatment, very high power is necessary which must preferably be transferred on to the steel bath.

The tests carried out so far with arc heating have produced important individual results. They justify the continuance of these tests until this form of heating becomes operationally sound.

"EXPERIMENTAL OPERATION OF A NEW BLAST FURNACE TOP DISTRIBUTOR"

by N. S. SHCHIRENKO, I. G. POLOVCHENKO, V. P. DOBROV and A. M. LABKOVSKII (Translation No. 4613 from Stal', vol. 18, 1958, No. 12, pages 1066–1071)

△ SINCE October, 1957, a stock distributor having an intermediate rotating hopper, has been in service on a blast furnace with a working volume of about 35,000 cu ft. The intermediate hopper, with a double-chute bottom and two discharge gates, is rotated by means of motor-driven tapered support rollers.

From a study of the operation of the new-type distributor during blast-furnace charging, before blowing in, it has been found that:

1. The intermediate rotating hopper distributes the stock charged into it by a 230 cu ft skip in 8 to 11 seconds, which is fast enough. There is no build-up of stock at the hopper discharge gates, showing that the dimensions of the gates and the slopes of the bottoms have been correctly chosen.

2. The optimum rotation rate of the hopper is 18 to 20 rpm; at higher rates there is build-up of stock at the walls and even some ejection of coke onto the top platform.

3. The 30-sec period of rotation of the hopper, used initially, is more than sufficient and will be reduced to 20.

4. The distribution of stock in the large bell hopper and in the blast-furnace stockline area is satisfactory.

The main shortcomings of the first experimental form of the new distributor are:

a. Insufficient capacity of the rotating intermediate hopper; with a skip-car capacity of 230 cu ft, it should have a capacity of not less than 160 cu ft instead of 88 cu ft, and this can be achieved by reducing the height of the lower part of the receiving hopper; the capacity of the intermediate hopper should generally be 0.8 to 0.9 of the useful coke capacity of a skip car.

b. Absence of the sight holes in the upper part of the small-bell hopper for direct observation of the stock distribution there.

c. Absence of an automatic signaling device indicating the presence of wrongly sized lumps in the intermediate hopper.

d. No dust protection for the rollers.

The new Shchirenko stock distributor gives a better distribution of stock, at the top of a blast furnace, than the conventional one.

In ten months' service of the new distributor, in spite of unfavorable working conditions in this period, a satisfactory gas flow distribution and good hearth operation have been maintained.

The use of the new type of distributor makes it unnecessary to rotate the small bell and its hopper (which eliminates the need for the complicated seal on the small-bell hopper), and also makes it possible to use the equalizing valves as auxiliaries (with increased pressure in the interbell space): this lengthens the service life of the large bell.

Operation of the distributor with no rotation by sitting at a fixed position is necessary only for eliminating channeling in the furnace.

Experience in the use of the new distributor with an intermediate rotating hopper has shown that it can be installed during a major repair without increasing the height of the top structure and the skip bridge.

OTHER AVAILABLE TRANSLATIONS

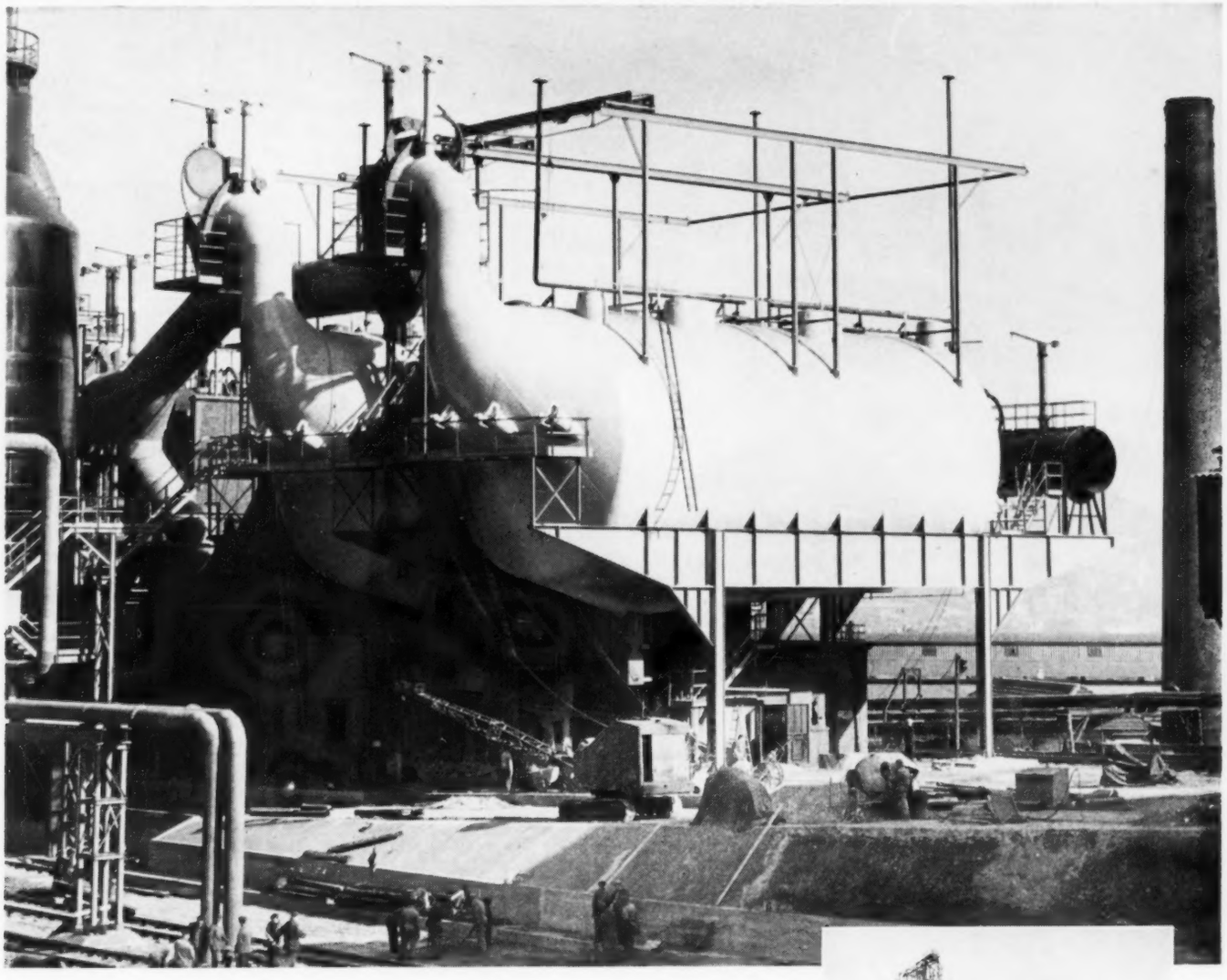
"Elimination of Oxygen in Vacuum Treatment of Liquid Steel," by H. Knüppel, A. Drevermann and F. Oeters, Stahl und Eisen, vol. 79, 1959, No. 7. Carbon-oxygen reaction in the degassing of steel by the vacuum-lifter process; rate-governing factors. Attainable degree of degassing. Duration of degassing; degassing rate compatible with a minimum period of lift. Effect of surface area of steel upon progress of degassing treatment; concept of lift ratio and its significance. Experiences gained in the vacuum degassing of carbon and chromium-alloyed steels. Relationship between oxygen in solution in melt and content of alloying elements in presence of relevant oxide; dependence of oxygen content on chromium content; practical conclusions drawn for vacuum degassing of 0.5 to 10 per cent Cr steels; confirmation by experiment. (Translation No. 4602)

"Experience with Vacuum Stream Degassing of Steel," by A. Tix, G. Bandel, W. Coupette and A. Sickbert, Stahl und Eisen, vol. 79, 1959, No. 8. Further experience gained on 78,000 tons of vacuum-cast steel for high-grade heavy forgings such as rotors, turbine shafts, and steel castings since author's earlier report in 1955. Results of new experiments. Hydrogen content of liquid open-hearth and electric furnace steels reduced by stream degassing. Application of vacuum treatment to steels for rolled semiproducts, and flake-sensitive rails having a minimum tensile strength of 128,000 psi without a slow cool. Reduction of oxygen content and more uniform distribution of oxygen in vacuum-poured ingots of carbon and alloy steel. Further experiences in improvement of properties, particularly avoidance of flake formation, minimizing streaks of segregate and over-all inclusion content. (Translation No. 4605)

"Commercial Vacuum Treatment of Steel for Rolling and Forging Ingots and Castings—A General Discussion," by K. Brotzmann and Others, Stahl und Eisen, vol. 79, 1959, No. 9. First experimental setup for vacuum-lift degassing, in Dortmund, Germany. Relative merits of vacuum-lifter (Dortmund-Hörde) and recirculation (Ruhrstahl) processes. Arrangement for injection of additional gas in vacuum-lifter process. Supplementary data on recirculation process. Turbulent vs laminar flow of metal in suction nozzle; determination of flowrates and steel throughputs (e.g., with Au-198). Experimental work on degassing of 40-ton heats in ladle; degassing after filling the mold. Nitrogen content. Present status of degassing. (Translation No. 4606)

"Ways of Avoiding the Formation of Flakes in Steel," by W. Küntscher and K. Werner, Neue Hütte, vol. 2, 1957, No. 5. A paper specially written for steel plant metallurgists who are kept too busy to follow the voluminous literature on the effect of hydrogen on flakes but would like to have a set of specific instructions on what to do when the next flake epidemic strikes. Melting unit. Sloppy practices in drying the lime. Drying of other charging materials. Refractories and ingot mold coatings. Degassing of liquid steel; rate of carbon drop at end of oxidizing period for lowest possible hydrogen content in open hearth steel. Degassing of solid steel by various practices. (Translation No. 4236)

"Redistribution of Moisture During the Sintering of Iron Ores," by A. A. Sigov, Izvestiya Vuz, Chern. Met., August, 1958. Experiments throwing light on the changes in vertical distribution of moisture in sinter beds during the sintering process, and refuting currently held opinions. Experimental procedure entailing interruption of pot sintering trials after the lapse of various times, and immediate study and recording of bed structure (consisting of zones of finished sinter: drying; condensation; and grate layer) and taking of samples for moisture content determination. Mechanism of condensation in zone adjacent to grate layer; variation of percentages of water vapor formed by evaporation that are carried away by the gases and that condense in the charge, in the course of the sintering process. Vertical temperature distribution in sinter beds as function of moisture content of charge. Evaluation of results of study. (Translation No. 4640)



BELOW 0.002 grains/cu ft

For extreme cleaning, S. A. Métallurgique d'Espérance-Longdoz, Liège, Belgium, have installed two SF Electric Precipitators for their new 1,500 ton/day blast furnace.

★

Gas quantity: 140,000 cfm. Design pressure: 21 psi.

Max. inlet dust concentration: 0.66 grains/cu ft.

Max. outlet dust concentration: 0.002 grains/cu ft — guaranteed and measured.

SVENSKA FLÄKTFABRIKEN

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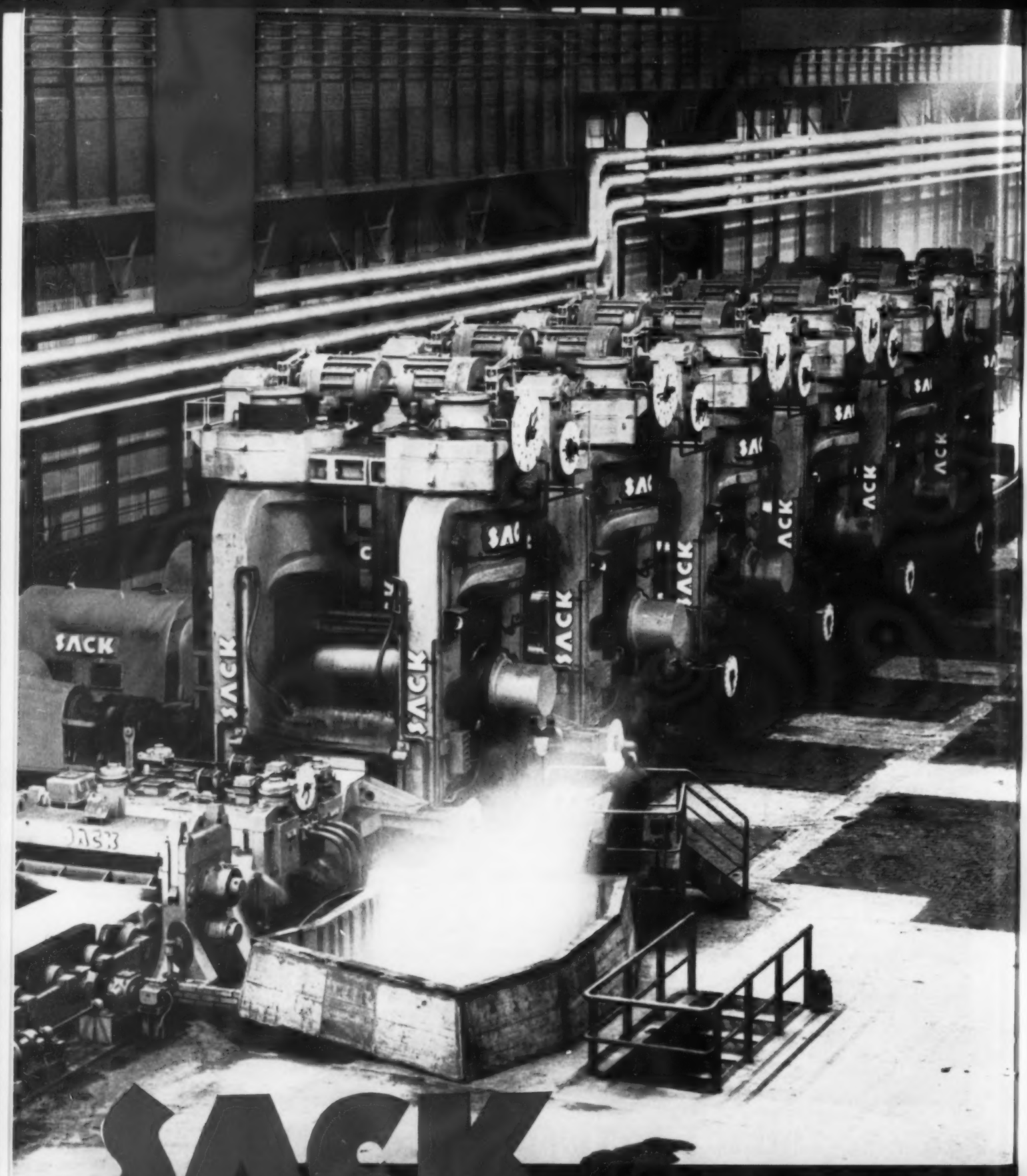

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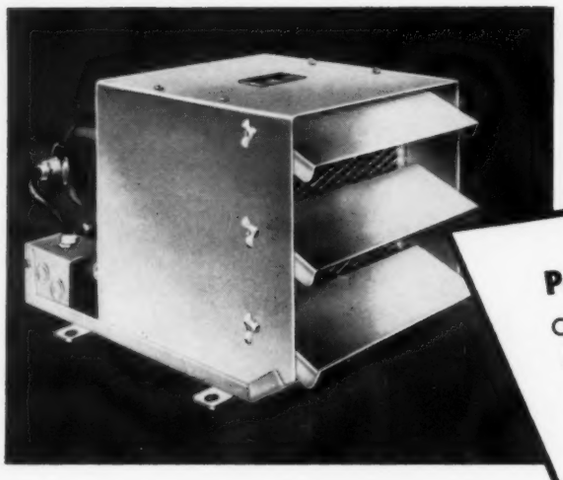

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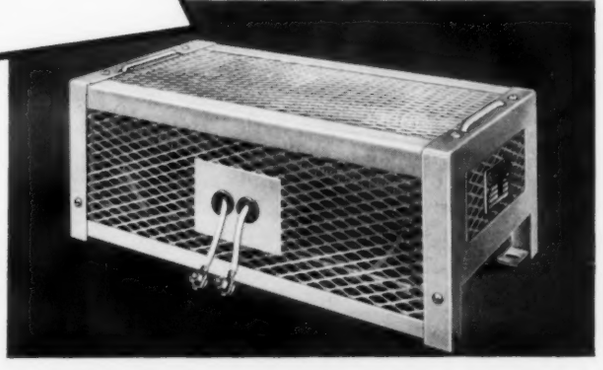
Ruggedly constructed, yet light in weight, they are easily portable by repair or construction workers. Ideal for permanent wall or floor mounting in crane cabs, etc. If a portable unit is desired, its disappearing handles may be used for ease in carrying. Made regularly in 3 to 6 KW capacity, 250 Volts, D. C.

TWO TYPES of HEATERS are available for industrial service. The heating element of both units is made of P-G Type T2, Chromium Steel Grids, which, because of their thin cross section, develop an unusually large heating area. A greater volume of warm air is so produced, and in addition, a more uniform heat distribution is obtained.



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P-G

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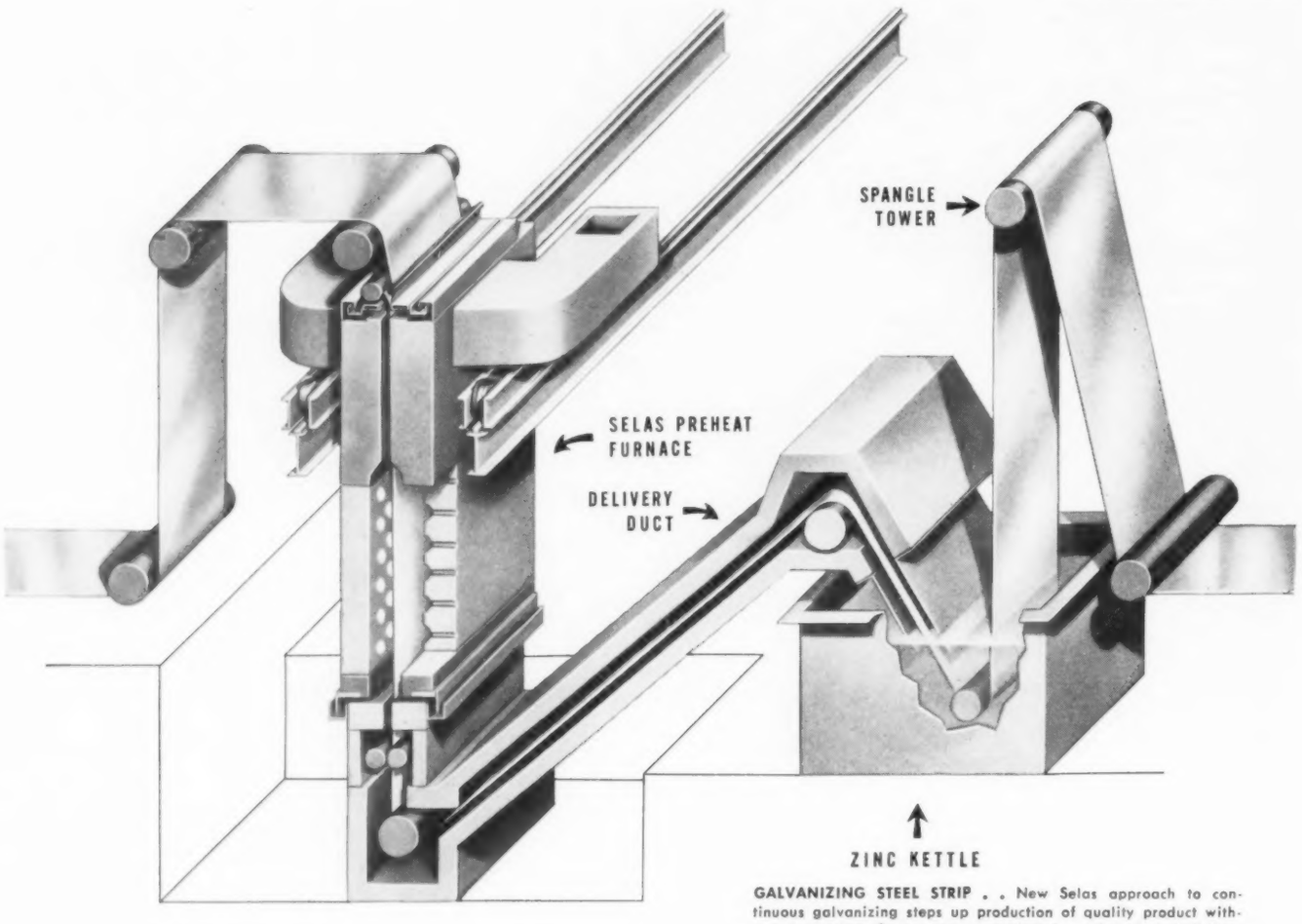

GALVANIZING STEEL STRIP . . New Selas approach to continuous galvanizing steps up production of quality product without increasing floor space occupied by original installation. Compact Selas vertical furnace quickly preheats strip to galvanizing temperature . . eliminates need for fluxing . . fits into line, replacing fluxing equipment. External firing of zinc kettle is minimized because evenly heated strip imparts heat to zinc bath . . achieving (1) longer kettle life, (2) less zinc consumption, (3) reduced dross formation and (4) uniform coating. Unusual safety feature provides fast, automatic withdrawal of furnace from strip in case of line stoppage.

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Throughout the steel industry—in mills and metalworking plants—Selas Gradiation heat processing is successfully used in many operations. The versatility and adaptability of the Gradiation principle are demonstrated by the diversity of applications shown in the installation photographs on facing page.

Gradiation is a concept and technique of heat processing which coordinates fast, controlled heating with the nature of the workpiece . . considering its composition, size, shape, heat transfer characteristics and physical properties . . to develop desired product quality, in minimum time, with maximum efficiency, and with the use of automatic and compact equipment.

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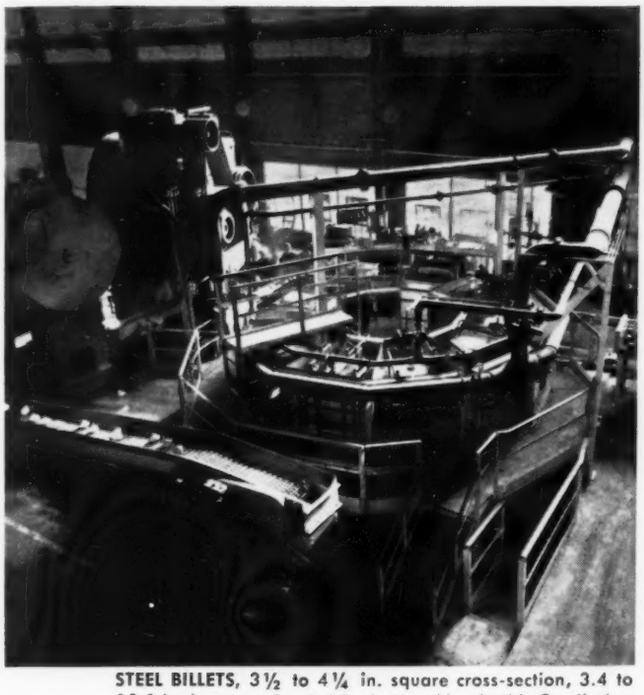
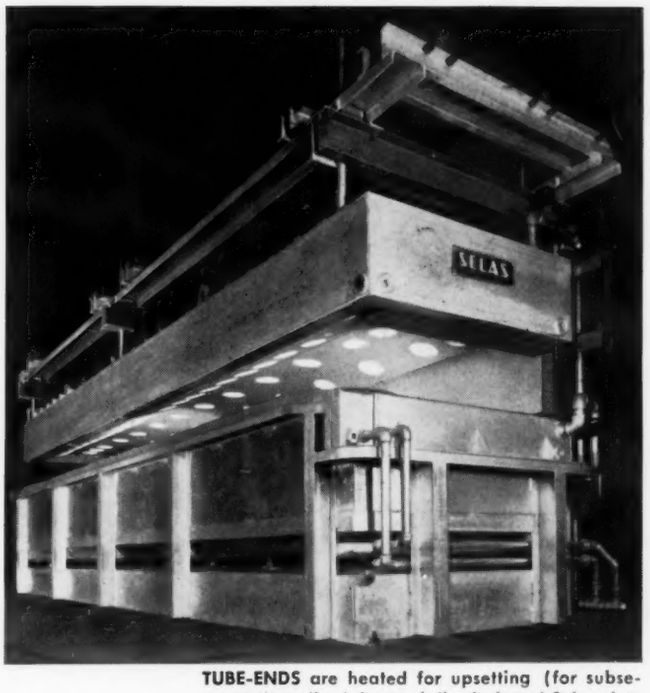
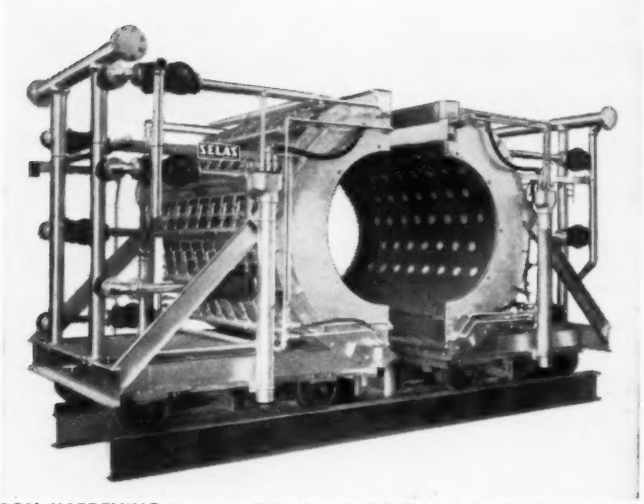


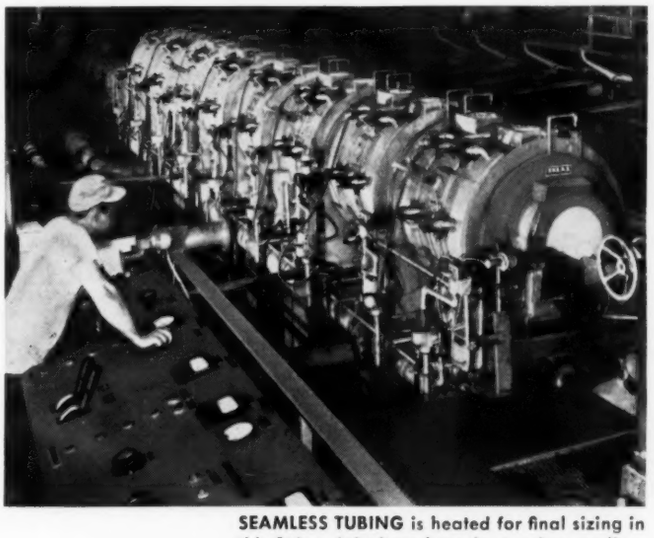
STEEL BILLETS, 3½ to 4¼ in. square cross-section, 3.4 to 10.8 in. long, are heated for hot working in this Gradiation rotary hearth. Compact furnace occupies 60% less floor space than required by conventional heat-and-soak equipment to achieve production rate of 11,000 lb per hr. Scale loss is 85% less. Entire heating cycle—as well as charge, discharge, transfer and press loading—is automated and synchronized with press operations.



TUBE-ENDS are heated for upsetting (for subsequent threading) in specially-designed Selas slot-type furnaces. As each tube-end is fast heated to upsetting temperature, the tubing automatically moves down the handling table to the upsetting machine. The direct-fired Duradiant® gas burners are patterned to assure temperature uniformity within a controlled section of each tube-end.



ROLL HARDENING is accomplished up to 12 times faster in this unique direct-fired Selas split furnace. Patterned Gradiation heating . . coupled with the ability to rotate rolls during heating and quenching cycles . . assures attainment of a controlled pattern of hardenability. Heat-up time is so rapid that harmful scale is eliminated. Even-heat distribution prevents formation of soft spots. Protection of roll shoulders leaves them unaffected by heat processing of roll barrel. Rolls up to 60 in. in diameter and a wide range of barrel lengths can be hardened.



SEAMLESS TUBING is heated for final sizing in this Selas eight-barrel continuous furnace line. Three zones of automatic control assure that the heavy-walled tubing . . up to 16 in. O.D. and 3 in. wall thickness . . is brought precisely to predetermined temperature, throughout each length of tubing . . consistently uniform from tube to tube.

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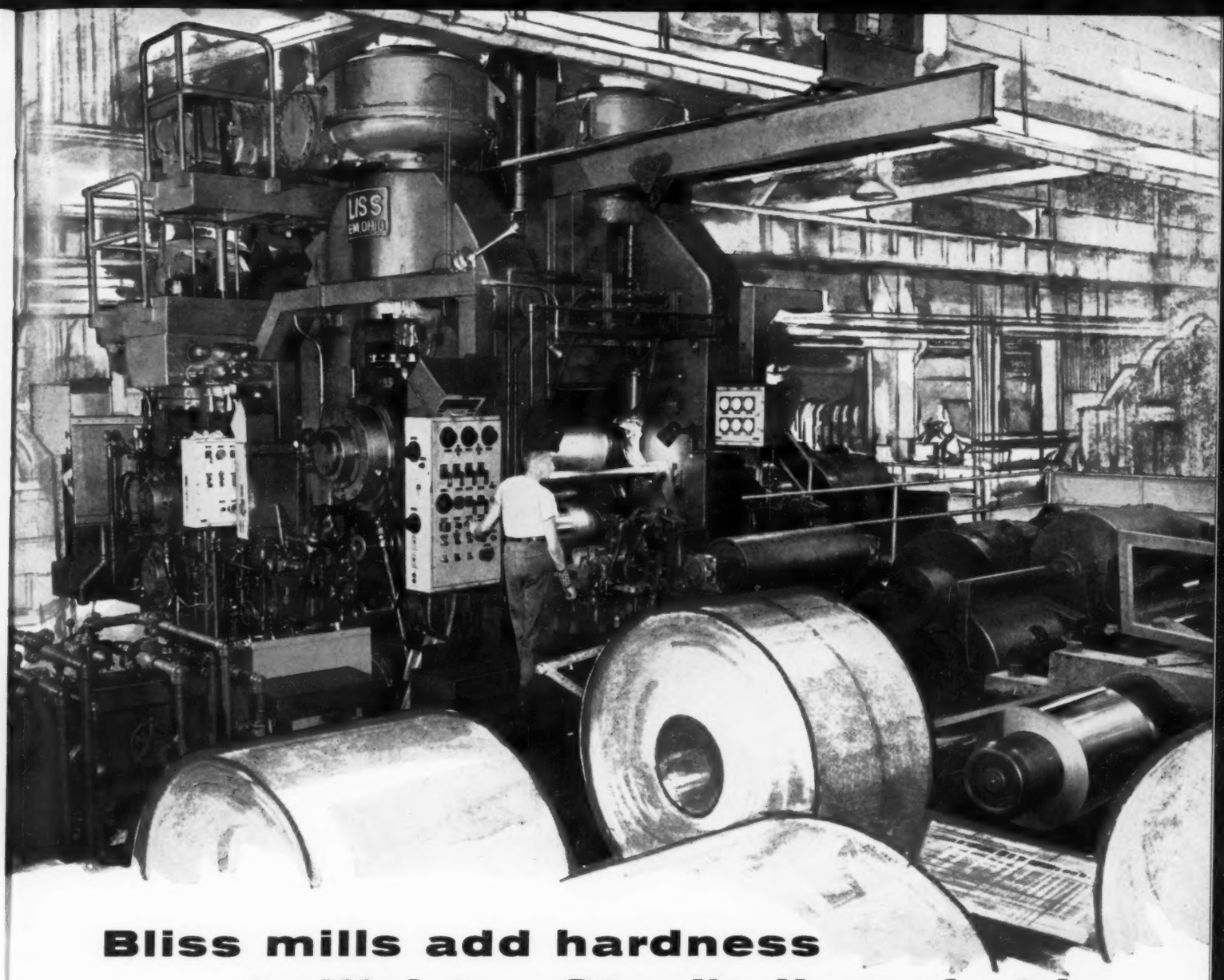


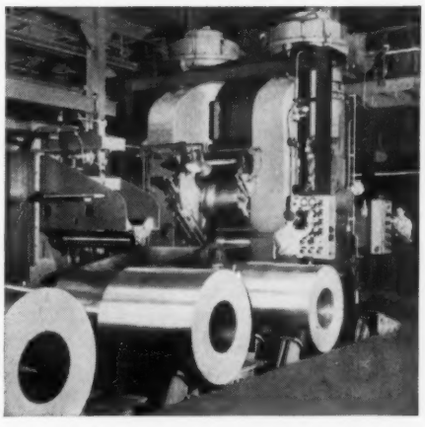
Bliss mills add hardness to Weirton Steel's line of strip

Weirton Steel Co., Division of National Steel Corp., the nation's largest independent producer of tin plate, uses a Bliss mill to achieve exacting temper and quality of its strip prior to plating. It is a four-high, two-high two stand tandem mill recently installed in its Weirton, W. Va., plant.

Through this unit Weirton has rolled a wide variety of steels in gages ranging from .00435 to .0147 inches and at an average maximum speed of 4,500 feet per minute. Well known products such as Weircote and Weirzin zinc coated steel are just two of Weirton's steel products to which this mill contributes.

A second Bliss mill tempers high-carbon, high-phosphorous, deep-drawing and galvanizing steels at the rate of 800 tons a day, while a new Bliss 48-inch slitting line is used to slit galvanized steel in gages from .0135 to .135 inches at speeds of 200 to 1,000 fpm. Both rolling mills are equipped with Amerigear-Bliss spindles.

These three installations provide one more example of the ready acceptance of the name of Bliss in the rolling mill industry—both here and abroad. To learn how Bliss equipment can help increase your rolling capacity, simply write for our new 84-page Rolling Mill Brochure, Catalog 40-B.



Four-high temper mill handles 30,000-lb. coils at speeds up to 3,500 fpm...has rolled 1,000 tons in a single day. Back-up rolls were supplied by Bliss' Mackintosh-Hemphill Division.

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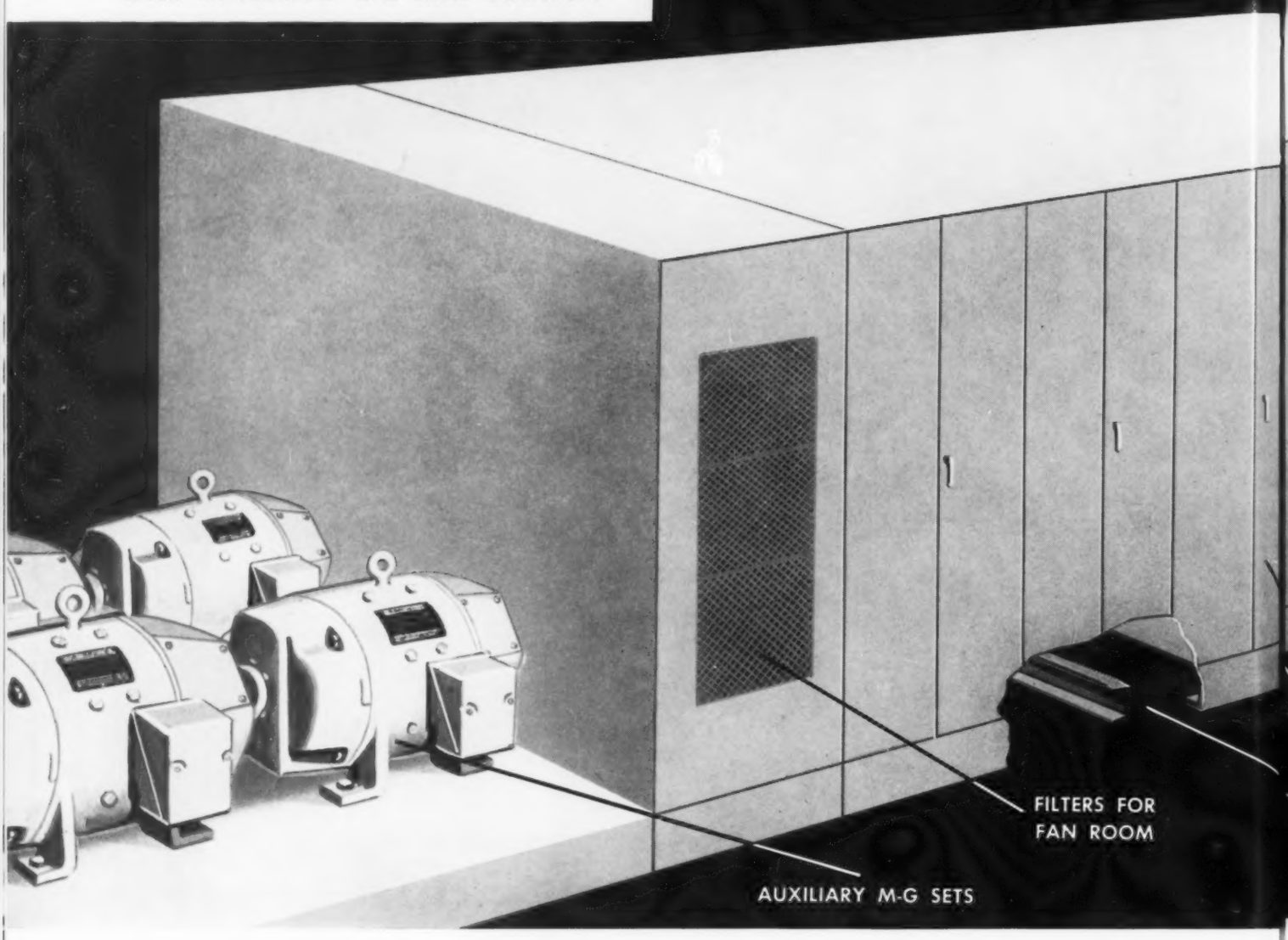


A NEW PRACTICE IN PROCESS-LINE CONTROL

G-E "packaged" motor-control rooms reduce

The latest innovation in modern steel-mill process-line control is General Electric's new "packaged" motor-and-control room. This novel design, developed jointly by General Electric and Jones and Laughlin Steel Corp., groups all controls and m-g sets into one compact centralized unit. The above unit will be installed at J&L's Aliquippa, Pa., works, as part of their continuing facilities-improvement program. Previously, the installation expense on this equipment often matched or exceeded the actual cost of the equipment. The new G-E motor-control room design cuts installation costs as much as 40 percent!

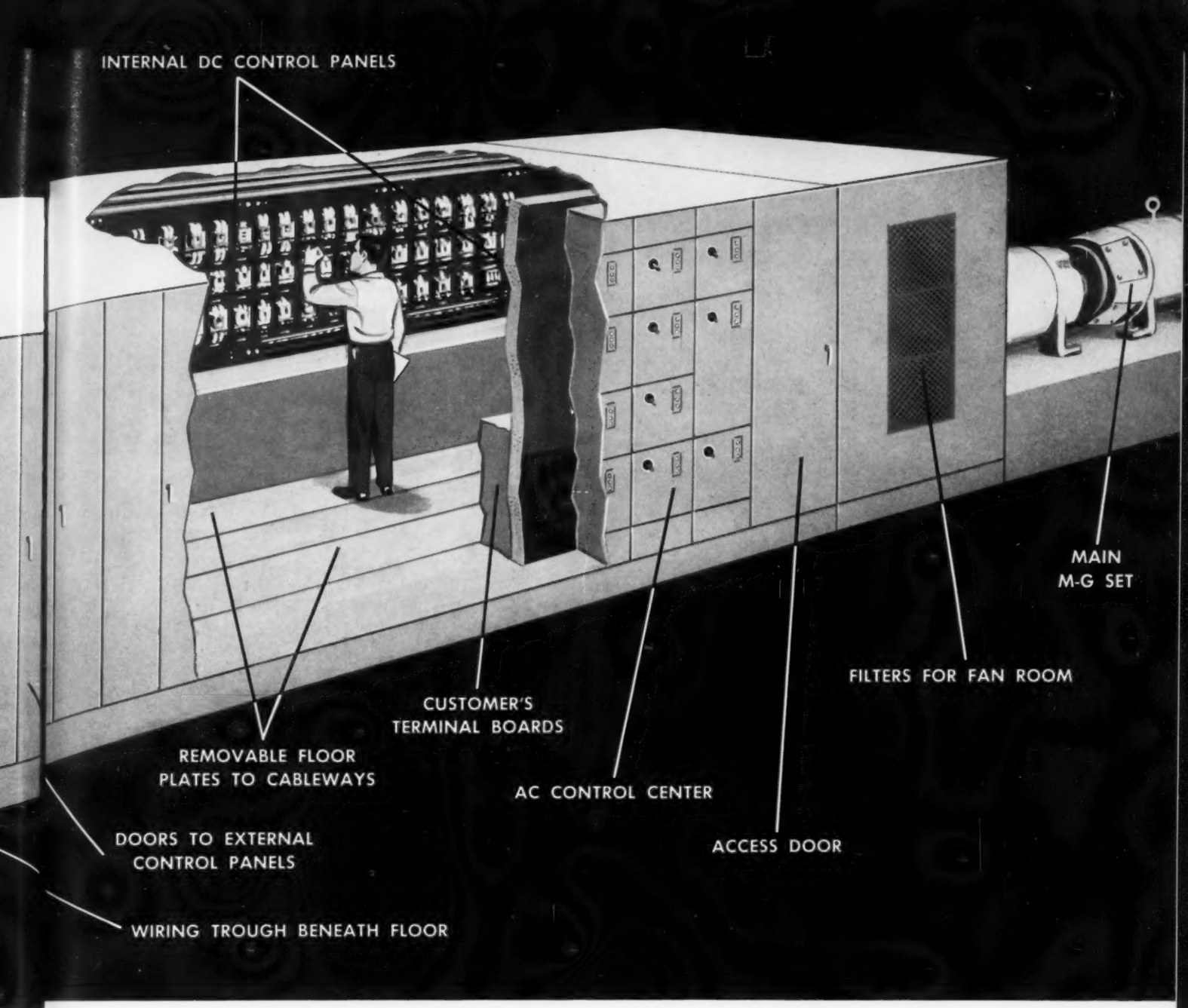
HERE'S WHY INSTALLATION COSTS ARE LOWER

Substantial savings on installation expenses can be realized through these features:

Independent control unit—The General Electric motor-control room is a completely co-ordinated, pre-assembled unit in itself, and in many cases, eliminates the need for a separate motor room. Since the motor-control room is self-contained, it may be located either near the driven equipment or in some previously unused area of the mill.

Field wiring is reduced by one-third or more—All internal connections are made and tested before the motor-control rooms are shipped. The only field wiring required is the connection of the power source and the leads to the operators' stations and the drive motors.

Construction engineering costs reduced—General Electric's grouped control concept enables the mill to know its conduit requirements much sooner. Thus, fewer, less-complex construction diagrams are needed, and actual construction can begin at an earlier date.



installation costs as much as 40 percent!

Common base minimizes installation time—This new "packaged" motor-control room, delivered on its own self-supporting platform, can be immediately set on a normal mill floor. It does not require expensive, specially-constructed foundations. With m-g sets built and shipped on a common base, the need to align them at the mill site is eliminated. In addition, regulating equipment is factory-tested prior to shipment, further expediting startup time.

For all the details on this new technique in process-line control, contact your G-E Sales Engineer today! General Electric Company, Industry Control Department, Roanoke, Virginia. 785-7

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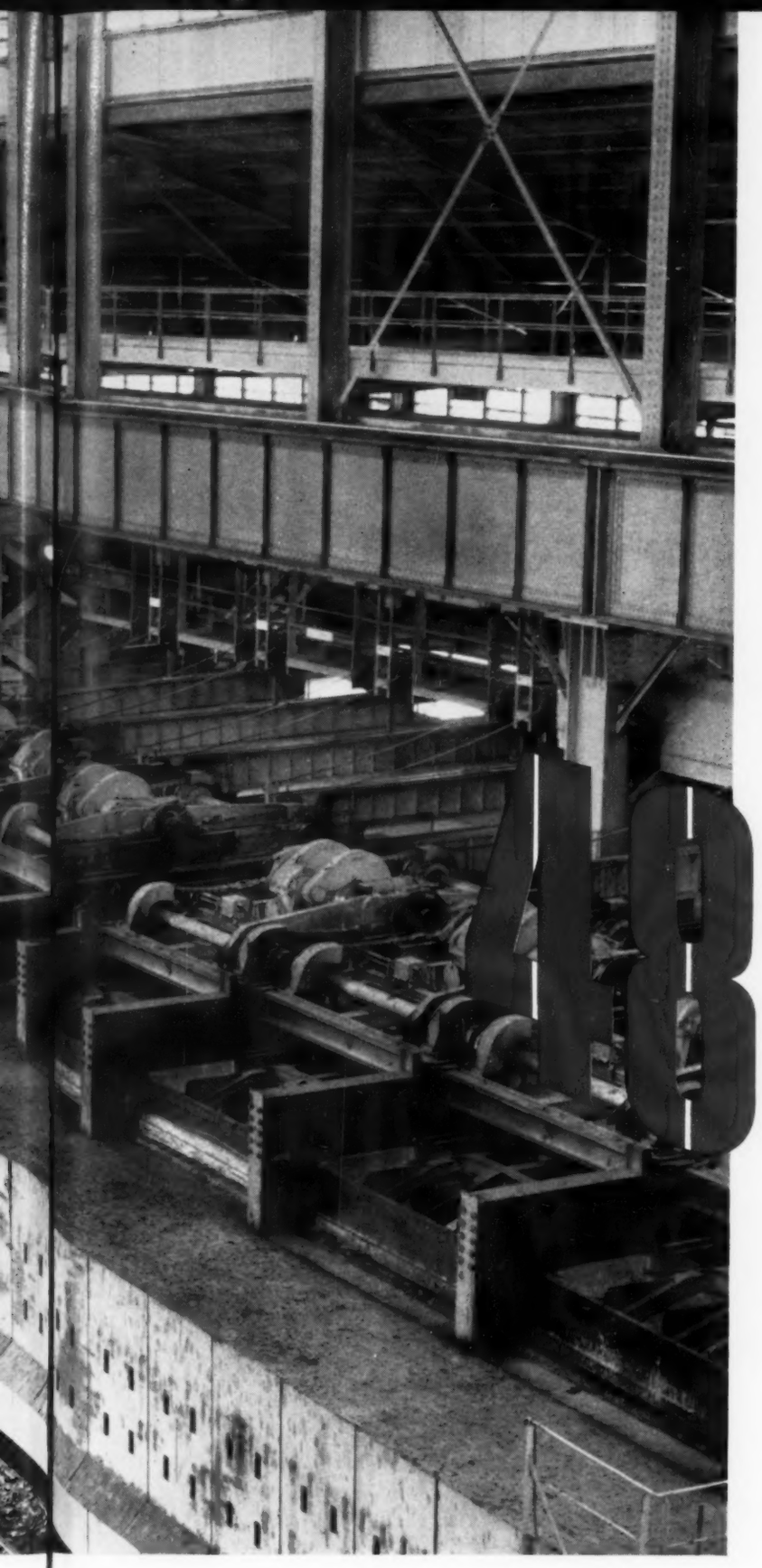

■ Forty-eight soaking pits on *one order*. There's a bold act of customer confidence for you! Confidence in the future, for one thing. Confidence in the principle of the Surface one-way fired soaking pit with the jet pump recuperator system. Many other steelmakers have shown similar faith in Surface—a source of pride, matched by our determination to deserve it, ***wherever heat is used in industry***

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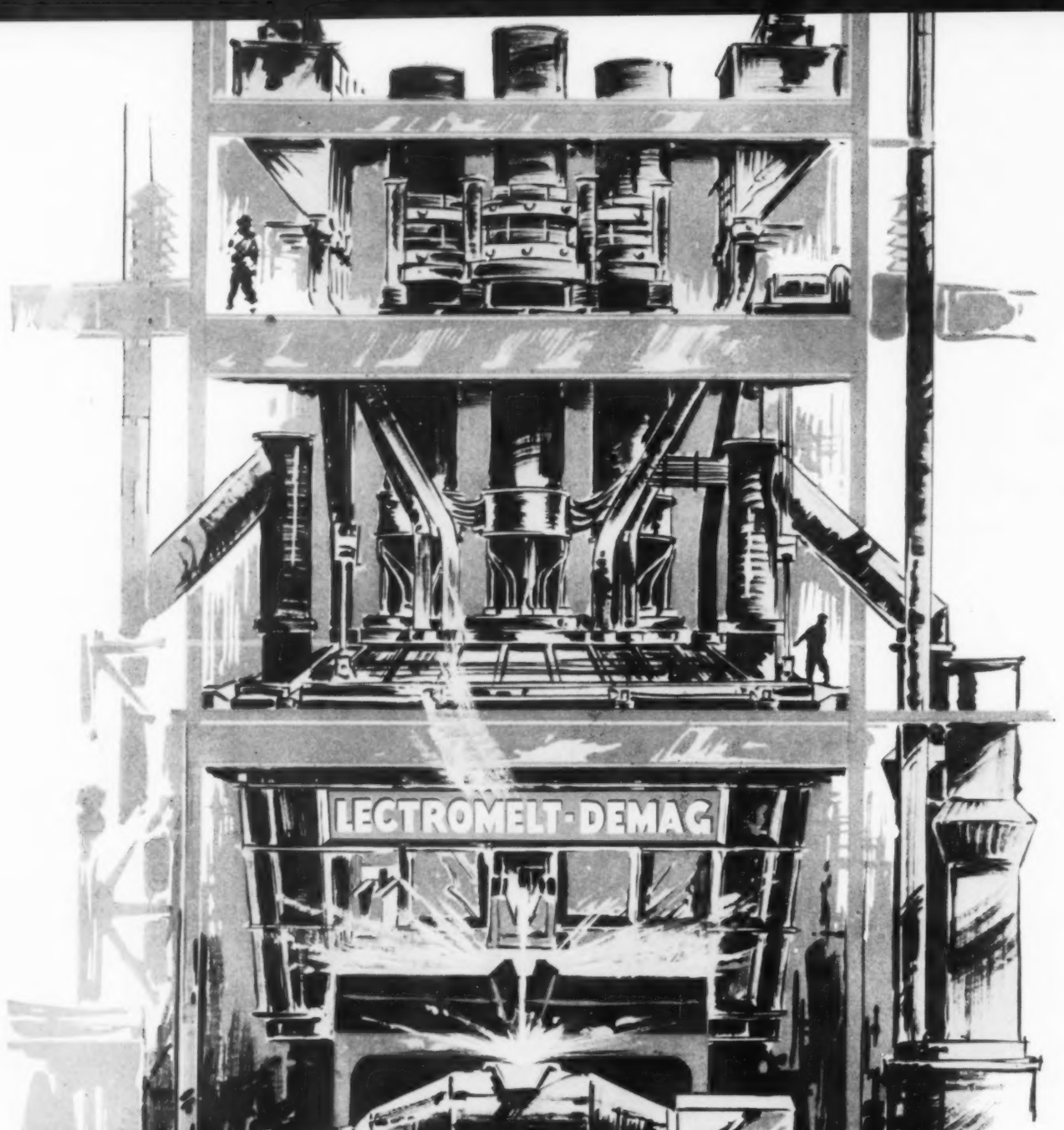

New highs in efficiency, economy and safety with LECTROMELT-DEMAG electric smelting furnaces

The advanced design of the Lectromelt-Demag smelting furnaces assures you of the highest electrical and thermal efficiency. For example, electrical losses in the electrodes are minimized by low-level electrode clamps. Hydraulic compression of contact clamps provides uniform pressure, preventing distortion.

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To this efficient Demag design, Lectromelt brings its experience in engineering and quality workmanship. The result is unmatched economy and dependability in all smelting applications.

For help in adapting electric furnaces to your requirements, contact Lectromelt Furnace Division, McGraw-Edison Company, 310 32nd Street, Pittsburgh 30, Pa.

FOR THE MOST EFFICIENT MELTING **Lectromelt®**

McGRAW EDISON

Modern Design Of Slab Reheating Furnaces

by H. C. Henschen, Special Engineer,
Fuel Dept., Bethlehem Steel Co., Sparrows Point, Md.

. . . . a 5-zone furnace proves to be flexible in that it can be operated as a 3-zone furnace for maximum efficiency at slow rolling rates; or it can be operated with high preheat zone temperatures for fast rolling, expected increased rolling, or quality heating and maximum soaking . . . .

WITHIN the past two years, Sparrows Point has built three different types of continuous slab reheating furnaces. None of these is of the conventional triple-fired type which has been so popular for many years. In order to understand why common practice was not followed, it is first necessary to understand the design and operating characteristics of the conventional furnace, Figure 1.

The conventional triple-fired furnace was designed to drive the required heat into the steel in the top and bottom-fired zones. It was not intended that any heat be added to the steel in the soak zone but rather that the steel be allowed to "soak out" for temperature uniformity. Roof height and bottom depth were set to allow for the combustion of the required amounts of fuel without excess flame impingement on the slabs. Inasmuch as combustion would be virtually complete within 25 ft of the burners, it was not necessary that roof height or bottom depth be maintained for the full length of the furnace. Therefore the roof and hearth were sloped toward the steel, and the products of combustion were thereby brought into intimate contact with the slabs to be heated. The cold steel extracted an appreciable amount of heat from the flue gases and was preheated several hundred degrees. Such a furnace was very efficient. Gases left the furnace at about 1600 F

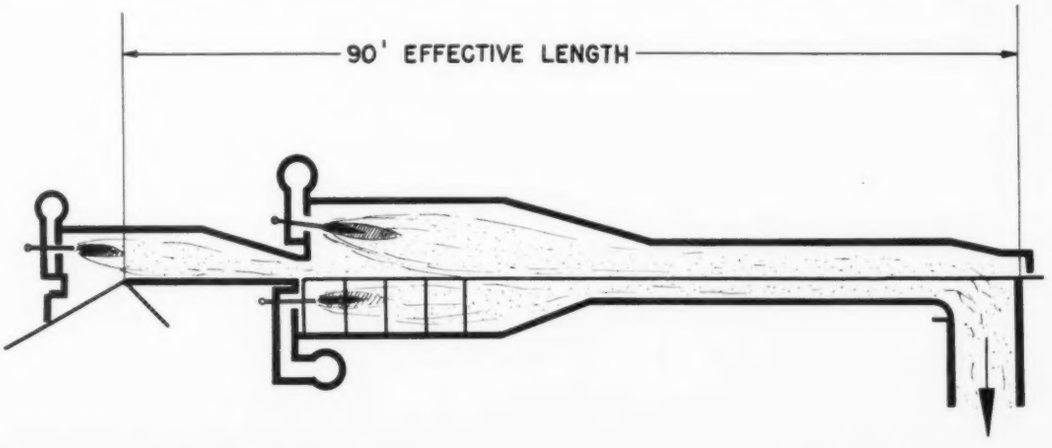


Figure 1 — The conventional triple-fired slab reheating furnace, whose vertical cross section is shown here, is very efficient.

and monthly fuel rates of 1,600,000 Btu per ton were quite common.

A 90-ft long conventional furnace of the type described was rated at 110 tons per hour. Three such furnaces were originally installed to serve most hot strip mills, but as mill tonnage increased, it was necessary to build a fourth furnace. Further increases in rolling rates necessitated increases in the fuel burning capacity of the furnace. Sparrows Point's 90-ft furnaces, for example, were made capable of burning approximately 1550 gal of oil per hr. It was then possible to heat 135 tons of steel per hr or 135 lb of steel per hr per sq ft of hearth covered.

It is important that the operating characteristics of the heavily fired 3-zone furnace be analyzed fully. The temperatures in the top and bottom combustion zones run very high, with roof temperatures over 2600 F quite common. These high "heat heads" make the furnaces tricky to operate. For example, if a mill shuts down for only a few minutes, it is necessary to reduce firing rates immediately. In addition, some plants find it necessary to continue pushing several rounds of steel through the furnaces, sending the unrolled slabs back to the slab yard. When first built, super duty refractories were adequate for furnace roofs. Now, with high firing rates, 60 per cent alumina roofs are the "order of the day."

By comparison, the top and bottom zones near the charge end run cold. By actual measurement, the roof temperature 8 ft from the charge door of our 90-ft long 68-in. mill furnace was only 1600 F. In the bottom zone, the temperature was only 1300 F, barely readable with an optical pyrometer. The 20-year charge end roof life of our 56-in. mill furnaces is offered as further proof that the charge ends of conventional furnaces run cold.

It has been common knowledge that to heat more tonnage in a 3-zone furnace, it would be necessary to increase the heat transfer rate in the charge zone. For example, by raising roof temperature from 1600 to 1800 F the radiation heat transfer rate is increased 50 per cent.

Much effort has been spent on the design of burners which will release less heat a few feet from the burner wall and more heat near the charge end of the furnace. Actually, this is not too difficult when gas is used as a fuel since gas and air leaving a burner at the same velocity, mix and burn slowly. With fuel oil, however, an intensely hot flame develops about 8 ft from the burner wall and, for the most part, combustion is complete within 25 ft. Efforts to slow down combustion by reducing the degree of atomization are only partially successful. When Sparrows Point tried a "long flame" oil burner on one of its 90-ft furnaces, the heat distribution actually became *worse*. For the same steel output temperature, top zone temperatures had to be raised to 2650 F (50 degrees higher than the other furnaces). Flue gas temperatures actually *dropped* 150 F. The flame from these burners was simply a better radiator, releasing its heat more quickly than the sharp flame burner which had been used.

Some 3-zone furnaces have been built with the top and bottom burner walls offset. Such a design has the following advantages. First, the hot spot from the bottom-zone and top-zone burners does not occur at the same place. Consequently, there is less tendency to "wash" the ends of the slab. Second, the top-zone burner wall is closer to the charge end, and higher charge end temperatures can be maintained.

Perhaps the earliest furnace specifically designed to do more heating in the charge end was the reverse-fired, triple-zone furnace, Figure 2. There is little doubt that such a furnace does a tremendous amount of heating near the charge end. However, so much heat is extracted from the flame by the cold steel just entering that it is difficult to establish the high temperatures that are necessary further along the furnace.

Of necessity, flue gases leaving such a furnace would exceed 2450 F. The recuperator would not only have to be capable of withstanding such high gas temperatures, but also it would have to be capable of preheating air to at least 1000 F in the interest of fuel economy. Correspondingly, the hot fan for such an installation must also be well designed.

Perhaps the latest development in the 3-zone furnace is the type installed in 1957 in the 160-in. plate mill. Many of the weaknesses of the early triple-zone furnaces have been overcome in this design, Figure 3. Note the large combustion spaces which have been provided by the 8-ft roof height and 6 ft-4 in. depth of the bottom zone. Note also that full-roof height and bottom-zone depth have been maintained for the full length of the furnace. There are two reasons for this. First, the hot parts of the furnace are free to radiate heat to the incoming steel. Second, the thick gas layer transmits more heat by radiation to the furnace roof and steel than would a thin gas layer. For this reason, the charge end of this furnace would be expected to run hotter and maximum heat heads could thereby be reduced.

This type of furnace was installed in the 160-in. plate mill because it was originally anticipated that the furnace would have to heat a mixture of hot and cold steel. Because of the plate mill order pattern the necessity of charging thick and thin steel in the furnace at the same time was anticipated. Heating such charges in a conventional furnace would be treacherous. Actually, no hot steel has ever had to be charged into these furnaces, but our slab thickness problem is worse than anticipated. Frequently 4, 6 and 9-in. thick steel are in the furnace at one time, and although it is difficult to

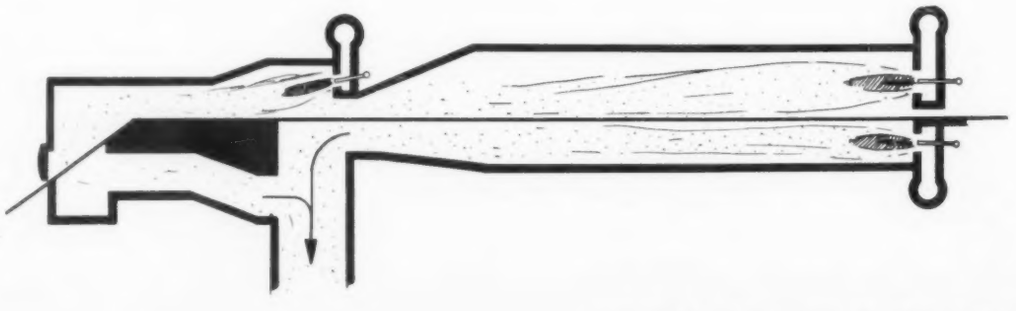


Figure 2 — Designed for more heating at its charging end was this reverse-fired, triple-zone furnace.

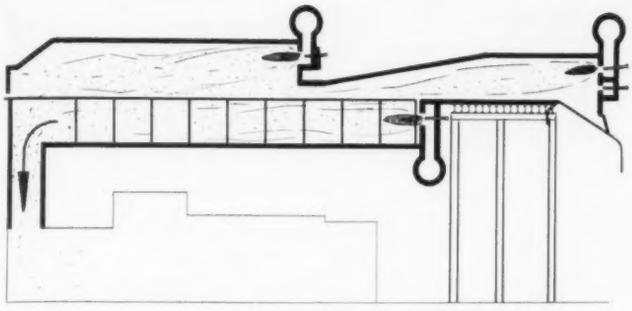


Figure 3 — This modified 3-zone slab reheating furnace overcame many of the objections of the furnace in Figure 2.

heat, the choice of this design of furnace is not regrettable.

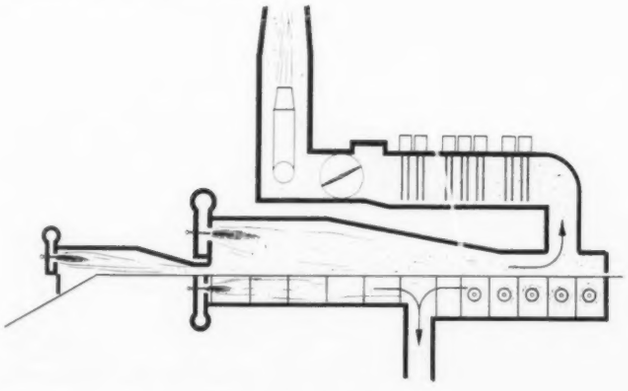
An interesting feature of this particular furnace is its burner arrangement. The top zone has but five large burners and the bottom zone only four burners. Here again, the builder attempted to maintain high charge end temperatures by using a small number of large burners.

These furnaces have not been operated over a long enough period of time as of December, 1958, to determine what tonnage they will heat. It is known, however, that it is possible to attain charge end temperatures of 2050 F when pushing steel at a rate of 140 lb per hr per sq ft. This in itself speaks well for the design changes.

There is one disadvantage. There is not as much top-zone heating capacity as bottom-zone heating capacity. Slabs have been observed with cool tops and hot bottoms passing under the top-zone knuckle, completely out of reach of the top-zone burners. Because of the offset top and bottom-firing zones the bottoms are exposed to an additional 11 ft of heating which seems unnecessary. It may be that the top-zone burner wall is offset too far.

In 1955 it became desirable to increase the tonnage output of Sparrows Point's 56-in. hot strip mill. Some mills, faced with increased demands for tonnage, added a fifth furnace. We could not, however, add a furnace without considerable expense in clearing the site. This would have necessitated relocation of the furnace control house, a large service building, and a water treatment station. Therefore, management preferred conversion of the existing furnaces for maximum possible capacity. For a while, we were plagued by proposals to merely increase the fuel burning capacity of the furnaces. These schemes would have increased tonnage on the longer slabs where our existing combustion air capacity and stack capacity limited furnace operating temperatures and production. However, in order to get the maximum possible capacity, it was felt that it would not only be necessary to increase the fuel burning capacity of the furnace, but that it would also be necessary to change the furnace temperature distribution in order to do more heating in the charge end.

Figure 4 — The 56-in. mill slab reheating furnace was rebuilt as a 4-zone furnace.



The furnace built, Figure 4, was a 4-zone furnace. Additional fuel burning capacity was added in the top zone and the bottom preheat zone. Additional drafting capacity was obtained by the addition of an overhead metallic recuperator and ejector stack which operates in parallel with the old tile recuperator beneath the furnace and the old natural draft stack. Combustion air from the overhead recuperator was piped to the soak and top zones of the furnace. Combustion air from the tile recuperator was piped to the bottom zones.

There were several features of this furnace design which were dictated as expedients of construction. Perhaps the most shocking is the center drafting of the bottom zone. With such a construction it was not necessary to move the steelwork under the old flue at the charge end of the furnace. This represented a considerable saving in money and conversion downtime. There are two disadvantages of this arrangement. First, the gases entering the tile recuperator are very hot. Hence furnace efficiency suffers. Second, the gases from the first two side-fired burners find an easier path to a stack by going up through the metallic recuperator. This tends to make the metallic recuperator run hotter than anticipated.

Another construction expedient was the use of side-fired burners in the bottom preheat zone. There was much concern about this design, and to this day, there is some question whether or not side firing harms the operation of the furnace. However, we have never seen any problems attributable to the side firing.

At first glance the control of the parallel drafting systems seems difficult, and a workable system was not had on the first try. The system now in use seems to work rather well although it is difficult to be absolutely certain that each recuperator and stack is carrying its share of the load.

Furnace pressure is controlled by the damper in the flue to the ejector stack. See Figure 5. The resulting flow of flue gas through the metallic recuperator is sensed by impulse taps upstream and downstream of the recuperator. A ratio regulator opens the damper ahead of the natural draft stack until flue gas flowing through the tile recuperator produces sufficient differential pressure to balance the differential across the metallic recuperator.

It is difficult to measure the success of such furnace changes. One hundred and eighteen tons of steel per furnace per hr were heated for eight consecutive hours with these 80-ft furnaces. This represents a 190-lb per hr per sq ft heating rate. We should like to point out the following reservations: first, the product was skelp, a heavy gage item on which maximum slab temperatures are not required; second, the furnaces were "spoon fed" to be sure that nothing was omitted which might give maximum output; and third, roof temperatures were quite high, 2800 F average.

Such rolling conditions are not common, and we have never again rolled at such a rate. However, it is not

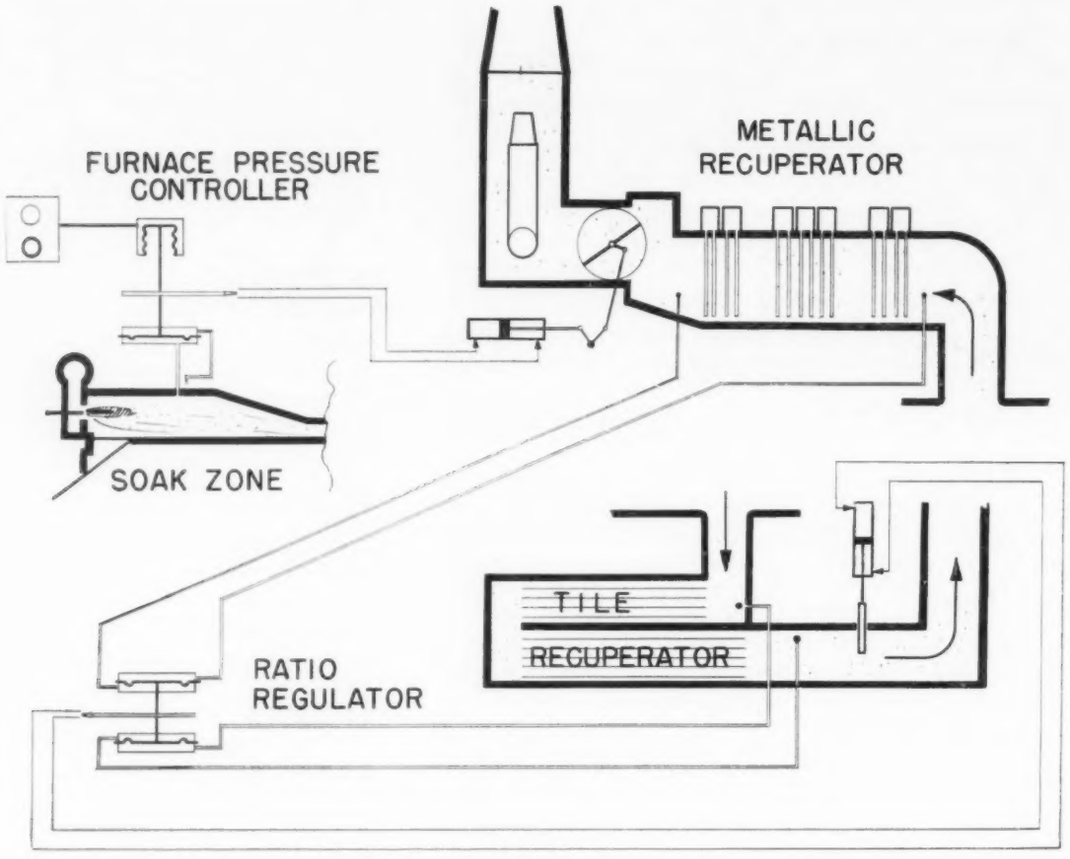


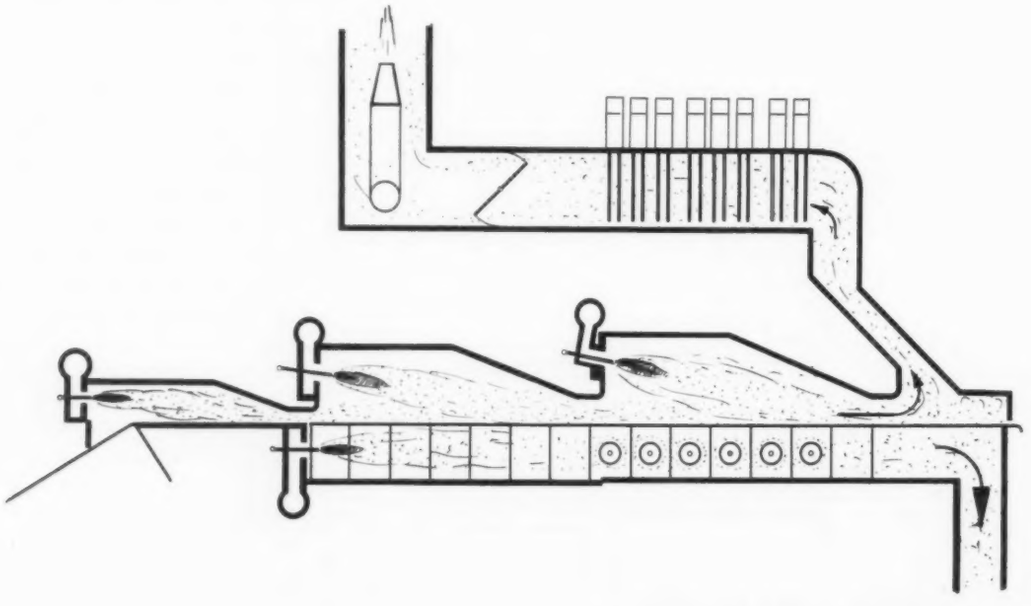
Figure 5 — Control for parallel flue system.

known whether ability to heat steel is limited by ability to heat the tops of the slabs. It may be that these furnaces should have had another zone of top firing. However, tight building conditions would have made construction of a 5-zone furnace quite expensive.

When called upon to increase the heating capacity of the 68-in. mill furnaces it was realized that an unconventional furnace design was needed even more than in the 56-in. mill. There was already ample fuel burning capacity for maintaining 2600-F roof temperatures on all slab sizes. Furthermore, the 10-ft additional furnace length was available, if fired, for increased output. Here was the ideal application for a 5-zone furnace.

A furnace was built which is capable of burning large quantities of fuel wherever needed to get desired temperature distribution. For example, such a furnace, Figure 6, could be operated as a 3-zone furnace for maximum efficiency at slow rolling rates. It could be operated with high preheat zone temperatures for fast rolling, for expected increased rolling, or for quality heating and maximum soaking. Whereas a conventional furnace usually suffers a delay after a sustained mill shutdown due to the inability to fire fuel as soon as the mill begins rolling, a 5-zone furnace could be fired almost right away. Such a furnace would rapidly approach the mill rolling rate, and no delay would be encountered. These

Figure 6 — This 5-zone furnace was designed for the 68-in. mill.



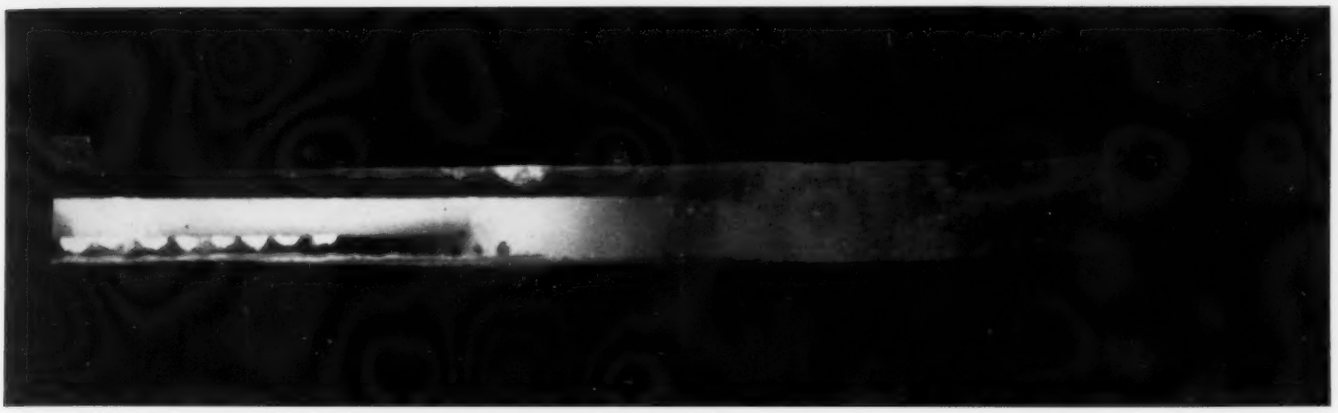


Figure 7 — Looking through charge door of the 5-zone furnace.

features were especially desirable for operation in conjunction with Sparrows Point's 68-in. hot strip mill because of a varied order pattern and frequent changes of mill rolling rates.

The rebuilt 68-in. mill furnaces are capable of firing large quantities of fuel oil where needed as follows:

Conventional top zone	800 gal per hr
Conventional bottom zone	700 gal per hr
Top preheat zone	600 gal per hr
Bottom preheat zone	800 gal per hr
Soak zone	200 gal per hr

On occasion, we have fired as much as 2700 gal per hr to one furnace. Figure 7 shows this furnace through the charging door.

In the interest of steel quality, these furnaces are *never* fired as conventional furnaces. Instead, the preheat zones are always fired hard with only 200 gal per hr fired in each of the conventional zones. Frequently 550 gal of oil per hr are burnt in the top preheat zone and 650 gal per hr in the bottom preheat zone. In spite of such high fuel inputs, so near the charge end, the cold steel entering extracts heat so quickly from the flame that roof temperatures near the recuperator uptake are only 1850 F. With this in mind it is not difficult to understand why more conventional furnace designs cannot possibly maintain high charge end temperatures. Figure 8 shows an uptake to the recuperator.

It is felt that the 68 in. mill furnaces closely approach the maximum heating rates possible with continuous slab reheating furnaces. It is difficult to say just what these rates are for several reasons. First, we have not been able to push these furnaces at high capacity for more than two hr at a time because of our order pattern and mill limitations. Second, it is difficult to pin down heating quality. Certainly, you could not expect to heat as many tons per hour of "deep draw" material as skelp. Even on the same grades of steel it is difficult to make comparisons between mills. Thickness going into the finishing train, water for descaling, and other factors

Figure 8 — Uptake to the metallic recuperator.

Figure 9 — The slab leaving the furnace exposes minor skid marks on the trailing slab.

make it possible to obtain the same mill finishing temperatures with as much as 80 F difference in steel temperatures from the furnace. We cannot point with pride to any tonnage records for our 5-zone furnaces, but we can most certainly say that we are getting quality heating at rather high tonnage rates.

We presently have virtually no rejections on the critical aluminum-killed grades whereas we have had monthly rejections up to 5 to 14 per cent. The metallurgical people are quite happy with the rebuilt furnaces.

Conversion of these furnaces posed many interesting problems, design of skid pipes for example. The replacement of skid walls with water-cooled cross skids and vertical skids and the increase in furnace temperatures near the charge end threatened to make an already bad water problem worse. For years we had been troubled by skid pipe failure from any of several causes: namely, flame impingement, loss of insulation, inadequate water pressure, poor distribution between skids, precipitation of solids from the reclaimed sewage water, etc. From an operating standpoint it was desirable to use as few vertical supports as possible but these designs required large diameter cross pipes with resultant high exposed surface areas. The "happy medium" was 5 ¼-in. cross pipes with two 2 ½-in. diam. vertical supports. Corebusters in all skids except running skids kept heat transfer rates high and minimized film overheating. Skids were separately fed and drained to solve any water distribution problems. Running skids were fed from the hot end in order to reduce water temperature rise and solid precipitation. Pre-fired, wire mesh reinforced, skid insulation was specified for the reduction of heat losses. The skid pipe design has passed the "supreme test." On one unfortunate occasion about 20 ft of slabs were melted right off of the skid pipes without damage to the pipes.

Discussion

PRESENTED BY

H. H. DINNEEN, Chief Engineer, Rust Furnace Co., Pittsburgh, Pa.

F. HARRY SPIESS, Fuel Engineer, Alan Wood Steel Co., Conshohocken, Pa.

LEE CONWAY, Executive Vice President, Bloom Engineering Co., Pittsburgh, Pa.

E. E. CALLINAN, Superintendent Masonry & Labor, Alan Wood Steel Co., Conshohocken, Pa.

CHARLES D. GUTH, Furnace Design Engineer, Lukens Steel Co., Coatesville, Pa.

H. C. HENSCHEN, Special Engineer, Fuel Dept., Bethlehem Steel Co., Sparrows Point, Md.

H. H. Dinneen: These 4 and 5-zone slab heating furnaces posed many interesting problems. The 5-zone furnace seems to me, particularly in the larger sized furnaces where maximum production rates are the order of the day, to be a natural development from the older existing types. Currently, there is considerable interest and discussion regarding the design of these furnaces, and one point that is of particular interest right now is the type of burners to be used on them. Some engineers are advocating that rather high-velocity burners be used, such as the type being used successfully on soaking pits, requiring pressures at the burner of 6-in. water column. To obtain such pressures a metallic recuperator is indicated. We would like the author's opinion on this matter.

Incidentally, in the design of these furnaces there was always a question about what would happen when you tried to fire oil into a blanket of waste gases from the other zones. This applies to the two zones added to

the charging end—and there was always much speculation about whether you could make it burn properly. The history of these particular furnaces indicates that there is no problem.

During the description of the improved 3-zone furnace and the 5-zone furnace, the author stated that the temperature at the charging end of the improved three-zone furnace is higher than for the five zone. I would like him to tell us why this is true.

F. Harry Spiess: At Alan Wood we have a conventional 3-zone slab heating furnace firing either oil or coke gas. It was originally designed for 50 tons per hour at about 100,000,000 Btu per hr input. Then, as the mill increased in tonnage, the furnace went to its maximum output, which we found to be about 80 tons per hour at 180,000,000 Btu per hour fuel input. We operated the furnace on straight bunker C oil except for a short trial period when we fired coke gas. Now we are faced with the problem of 100 per cent coke gas firing, and in preparing for this, we are trying it out separately on the top and bottom zones. However, we have found that when firing gas on the top and bottom zones, our tonnage has suffered, due to several reasons, mainly lack of air and combustion space.

I would like to ask the author if he has found an increase, or decrease in tonnage with one fuel over the other. Do you vary your total Btu input when changing from gas to oil, and also is the temperature schedule changed when firing the various fuels?

The question of a luminous flame when burning coke gas is always an interesting one, and I wonder if you have been able to obtain such a flame when burning coke gas. If so, could you give us some information on your burner setup.

The scheme of a 5-zone fired furnace certainly is one way of increasing tonnage of a conventional 3-zone slab heating furnace.

Lee Conway: Mr. Dineen mentioned the problem of air pressure in the burner. I would like to know what the author's comments are on this particularly with the point in mind that in a multi-zone furnace all of the fuel fired in each zone must be burned in that zone.

E. E. Callinan: I would like to know first, with reference to the production rates you spoke of, are you able to maintain those, hour after hour, or are you limited perhaps to one or two hours, and then have to slow down because of inability to maintain those high production rates?

Secondly, it would be interesting to know your average mill delay time.

A third question is the matter of the control of the heat on the slab ends. I believe you mentioned that your problem was that you were tending at times to overheat them.

I would like to know on the conventional type—not the 5-zone furnace—how you do control those, particularly when you have five burners only on the respective firing zones?

Another question is with regard to the cross-fired burners in the bottom preheat zone. Are those burners opposed or are they staggered?

Mr. Spiess asked about coke-oven gas experience or any gas experience. We are interested in knowing how that would vary with conventional fuel oil in any respect.

Another question I am interested in is, what is the theoretical air-fuel ratio you tend to maintain on the various zones, speaking in terms of the air-fuel ratios at the panel board?

Another question is, in the case of mill delays, do you experience any chilling on the discharge end and if so what do you do about it?

The final question is, what normal furnace pressure do you maintain?

Charles D. Guth: You mentioned that you run slabs of varied thickness through the furnace, what adjustments do you make to handle this material? Do you have a problem moving the steel through the furnace?

H. C. Henschen: The "new look" in one-way fired soaking pits is the high-velocity burner. The high kinetic energy of the air and gas streams at the outlet of this burner is supposed to cause recirculation of large quantities of flue gas within the pit, flame dilution and improved top to bottom heat distribution.

I do not believe that such flame tempering is desirable in a slab reheating furnace, especially one with five zones. It seems reasonable that you can transfer heat faster to the slabs and brickwork with a 4200-F flame than with a flame which has been diluted with flue gas. Large driving forces should be utilized, if available, and distribution acquired by additional zones or burners.

Why is the temperature at the charging end of the modified 3-zone furnace higher than the temperature at the charging end of the 5-zone furnace? In answering this I should like to compare Figures 1 and 6 of these two furnaces. First, note that the offset between the top and bottom zones of the 3-zone furnace shortens the top zone by 11 ft. Second, note that the soak zone of the 3-zone furnace is 6 ft longer than on the 5-zone furnace. Third, note that the 3-zone furnace is only 80 ft long vs 90 ft long for the 5-zone furnace. Therefore, the top zone of the 3-zone furnace is about 27 ft shorter than the top zones of the 5-zone furnace. Furthermore, the high roof at the charging end of the 3-zone furnace is cooled less by the cold steel entering than is the much lower knuckle at the discharge of the 5-zone furnace. In other words, the two temperature readings are not completely comparable.

What is the effect on tonnage of changing from fuel oil to coke-oven gas in the top and bottom heating zones? Coke-oven gas does not produce a very luminous flame. Therefore, it travels through the first part of the heating zone without giving up much heat to the steel and the furnace. The waste gases are hotter, and charge end temperatures rise. However, the increase in heat transfer rate in the charge end is not as great as the decrease in heat transfer rate in the combustion area. Consequently, tonnage output suffers.

In answer to the question of obtaining a luminous flame with coke-oven gas, we have not been able to produce gas flames which approach the luminosity of fuel oil flames. When considering the great difference in chemical analysis between the two fuels, I believe that obtaining similar flame characteristics is virtually impossible.

We do not directly change Btu per hr fuel input when switching from oil to gas. The automatic controls simply take off say 50,000,000 Btu per hr of oil and replace it with 50,000,000 Btu per hr of gas. However, the difference in flame characteristic is sensed by the

roof thermocouple and the fuel input is thereby readjusted. The thermocouple is not always "smart enough" to make this change and hold output steel temperature at exactly the same value so that it is frequently necessary for the heater to trim the temperature control index slightly. This is particularly true in the soak zone where air coming up the dropout drives the gas flame toward the roof and the thermocouple.

About hour after hour production rates on the furnaces, we do not have sustained heating rates for the modified 3-zone furnaces. Two such furnaces serve the 160-in. plate mill and have little trouble supplying the necessary steel. We have had a couple of hours of steady rolling on large skelp orders which indicated that heating rates of at least 140 lb per hr per sq ft of hearth covered could be maintained.

We have heated steel in the 56-in. mill furnaces at a rate of 190 lb per hr per sq ft for an 8-hr turn. We have not had such a continuous rolling in the 68-in. mill where our best measure was a 2-hr skelp rolling at 200 tons per hr per furnace. Inasmuch as each furnace holds about 265 tons of steel (or 1.3 hr rolling) a 2-hr rate is hardly a fair measure. I do believe, however, that this rate could be maintained for eight hr with ease.

Average mill delay time is about 15 per cent in our hot strip mills.

Regarding the overheating of slab ends, I believe that this problem will never be completely solved. The end of the slab not only represents additional heat absorbing surface but it also is exposed to more heat releasing gases and radiating furnace walls. In the 5-zone furnace, heat heads in the old top and bottom zones are reduced considerably, and washing of slab ends is minimized.

We do not notice any ill effects from the small number of large burners in the modified 3-zone furnace. This is due, I am sure, to the large depths and heights of these zones and the lack of flame impingement.

The burners in our side-fired zones are opposed although I doubt that it makes much difference.

Regarding air-fuel ratio, I must admit that at Sparrows Point we talk very little about theoretical air-fuel ratio. This applies to soaking pits and all types of heating furnaces. We tune the furnace controls until we get the desired flue gas analysis. This is as close to zero oxygen-zero combustibles as we can get.

Yes, we do have chilling of the edge of the first slab on the hearth during a mill delay. I believe that this is caused by two things. First, a considerable amount of air comes up the dropout slope by natural draft or by the inspirating effect of the soak zone oil burners. This air chills the steel. In addition, the doors, water-cooled dropout skids and almost everything in the dropout area are high-heat-loss items. Therefore, the whole area tends to run cold and the edge of the slab loses much of its heat by direct or indirect radiation. On the 68-in. hot strip mill the cold air infiltration can be reduced by operating what we call the "hearth eductors." These eductors pull 1750 cfm of infiltrated air from the dropout slope. This saves some fuel (about 20 gal per hr) and does, perhaps, help keep slabs from chilling during mill delays. Of equal or greater importance, however, is keeping the front edge of the slab back off the knuckle by at least one foot.

In answer to the question on furnace pressure I would normally say "neutral at the skid line." This is equivalent to a pressure of 0.075-in. water column in our soak zone roof. However, on any top-drafted furnace, it is important that you do not infiltrate air through the charge doors. Therefore, to satisfy that condition, the furnace pressure must be raised slightly, say to 0.085-in. water column.

About handling slabs of various thicknesses, may I say that the only way to heat them is to slow down and wait. There is 50 per cent more steel in a sq ft of 6-in. slab than in a 4-in. slab. Furnace temperatures *must* be held low to prevent over-heating of the 4-in. slab while waiting for its 6-in. neighbor to get hot. The improvements in furnace design mentioned in this paper go a long way toward improving this condition, but they are no cure-all.

I cannot give a definite answer on moving slabs of varying thickness through the furnaces. We do occasionally have trouble but we have no fixed "recipe" of what we can and cannot do. Difficulties encountered are a function of differences in slab thicknesses, condition of hearth and skids, slab "shape," etc. However, we have one cardinal rule. We do not push steel of less than 4-in. thickness through any continuous furnace. ▲

1960 AISE
SPRING CONFERENCE

Auspices of Rolling Mill Committee

April 25, 26, 27

Sheraton Hotel

Philadelphia, Pa.

Modern Regenerative Soaking Pits

by Henry S. Hall,
Manager,
Combustion Control Div.,
Morgan Construction Co.,
Worcester, Mass.

. . . . regenerative soaking pits can be designed for the entire range of fuels from straight blast furnace gas up to and including bunker C oil . . . .

FOR many years the regenerative soaking pit was the only type of pit used to heat ingots for rolling in blooming or slabbing mills.

The soaking pit developed from its original inception from a unit with no heat added, to a time when heat was added, and then finally became a heating furnace.

The original pits were usually heated with producer gas, and the controls consisted of a steam valve for regulating the steam to the gas producers and gas and air valves in the flues for reversing and damping of the pits. Heating at that time was an art.

After the price of coal increased and the wages paid to labor increased, the cost of producer gas became too high and coke-oven gas and natural gas were substituted in its place.

These higher Btu gases required closer attention on the part of the heater. In many instances this was lacking, and the result was poorly heated steel, and in many cases burned steel. Some attempts were made to improve the facilities for controlling regenerative pits, but inasmuch as they were usually built in blocks of three or four holes this presented quite a problem.

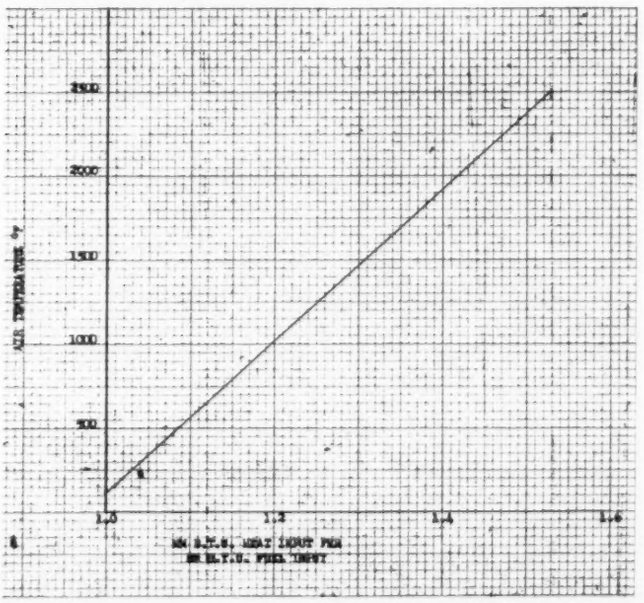
The recuperative pit or one-way fired pit was developed and seemed to lend itself very well to the burning of coke-oven gas, natural gas or oil; and a great many of these were installed.

However, it was found that this type of pit also had certain limitations especially where blast furnace gas, which is an ideal soaking pit fuel, was available. Blast furnace gas requires high-temperature combustion air for maximum efficiency, and although this may be possible with a recuperative pit, the initial cost of the recuperator and also its maintenance at these high air temperatures is much higher than regenerators.

The flame temperature in the soaking pit should not be high except in certain types of soaking pits where you are dependent especially on radiation from the flame itself to transfer heat to the steel.

In the modern regenerative soaking pit where the

Figure 1 — Available heat to the furnace is a function of the preheat temperature of the air.



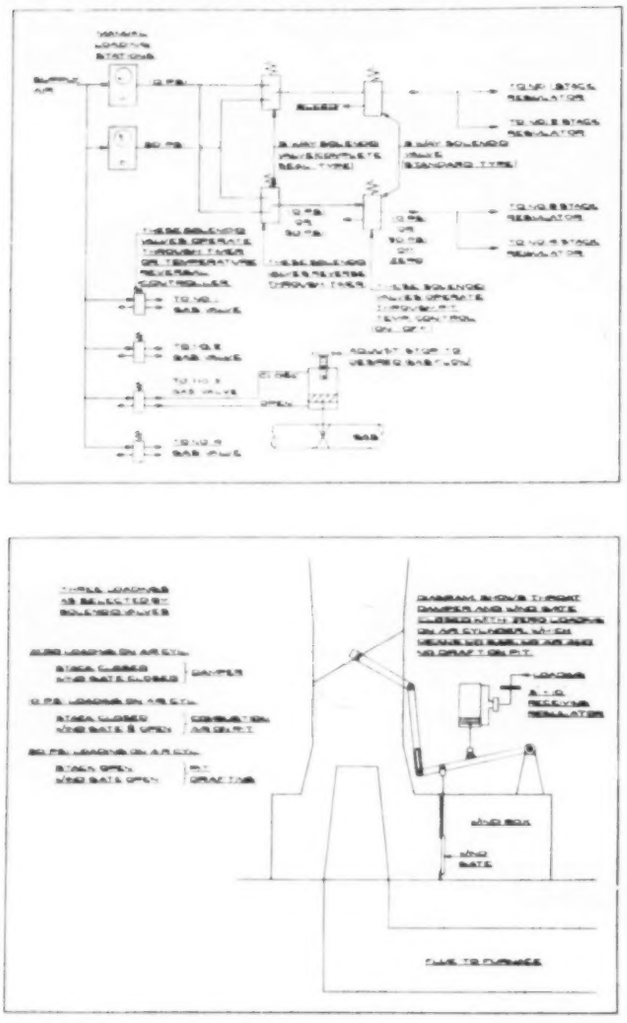


Figure 2 — This is the basic regenerative soaking pit with on-off controller.

flame is in contact with the steel in the pits, the flame temperature should be kept down but the total amount of heat available in the flame and the gases should be high. This is where high air preheat temperature is of great benefit.

The curve in Figure 1 shows the total amount of heat available to the furnace with various air preheat temperatures per million Btu from the fuel. To illustrate, if the preheated air temperature entering the soaking pit is 500 F, the total heat input to the furnace per million Btu of fuel will be approximately 1,085,000 Btu. If the air temperature is increased to 1000 F, the total heat input per million Btu will be approximately 1,196,000. At 1500 F it will be approximately 1,305,000; at 2000 F it will be 1,418,000; or in the case of 2000 F air versus 500 F air, the total heat input will be 30 per cent greater due to the heat in the combustion air. As will be seen later in the paper, soaking pits are in operation where the preheat is higher than 2000 F.

It has been our privilege during the past three or four years to work with some of the furnace companies and also with various steel companies in the modernization of some existing regenerative soaking pits and also in the design and installation of entirely new soaking pit installations.

In the design of any heating furnace there is always one point of fuel input at which the furnace works best. If this is exceeded or less fuel is fired than this optimum amount, the furnace does not perform nearly as well. For this reason on-off temperature control has been used on all of the regenerative soaking pit installations that the author's company has been concerned with recently. This allows for the most efficient design of burners, checkers, ports, flues, etc., without any compromise being necessary to handle various fuel inputs. This also has simplified the control systems for each hole of soaking pits.

Basically the control consists of a recording and controlling temperature instrument using on-off control, The fuel is set manually, the combustion air is set manually, the draft is set manually and the pits are reversed by a time cycle controller. When the fuel is off, the combustion air is off and the pit is damped up tight. This system is shown basically in Figure 2.

There have, of course, been variations to this control system in which furnace pressure has been added and also in which venturi throats for metering the combustion air have been supplied, but no attempt has been made to apply fuel-air ratio control. This basic control system was devised by one of the steel companies which also started using a new method of firing soaking pits. They originally had 48 holes of regenerative pits cross-fired in the conventional manner. The holes were relatively small; and as their ingots became larger, it became necessary to add or obtain additional heating capacity. Their method of doing this was to remove the center wall between two adjacent holes of soaking pits, cover this hole with a larger cover, and fire them in the manner shown in Figure 3.

The fuel used in this installation was a mixture of blast furnace gas and coke-oven gas having a heating value of approximately 117 Btu per cu ft.

This same idea was used in another installation of 12 holes of soaking pits where the fuel used was straight coke-oven gas. The firing arrangement remains the same as previously described, and the control system is practically the same.

In this second steel plant the balance of the regenerative pits were in need of rebuilding; at the time this was under consideration, a change in the size of the strip mill necessitated a change in the size of the ingots. The old pits were going to be slightly small for the new ingot size, and it was decided to increase the size of each individual soaking pit a foot or so in width and two or three feet in length. This was going to cut down on the available checker capacity so that it was deemed necessary to add additional checker capacity in the bases of the ejectors. The general layout of these pits with some small checkers in the bases of the ejectors is shown in Figure 4. There are eight holes of this design.

This same idea was used on another soaking pit installation of four holes where straight natural gas was the fuel and is shown in Figure 5.

Figure 6 shows an installation of soaking pits in which all of the checkers are in the bases of the ejectors, no checkers being adjacent to the soaking pit proper. This was done to secure maximum utilization of the space under the crane runway in the soaking pit building for heating steel.

This is believed to be the first installation of upside down checkers, i.e., where the gases come directly from

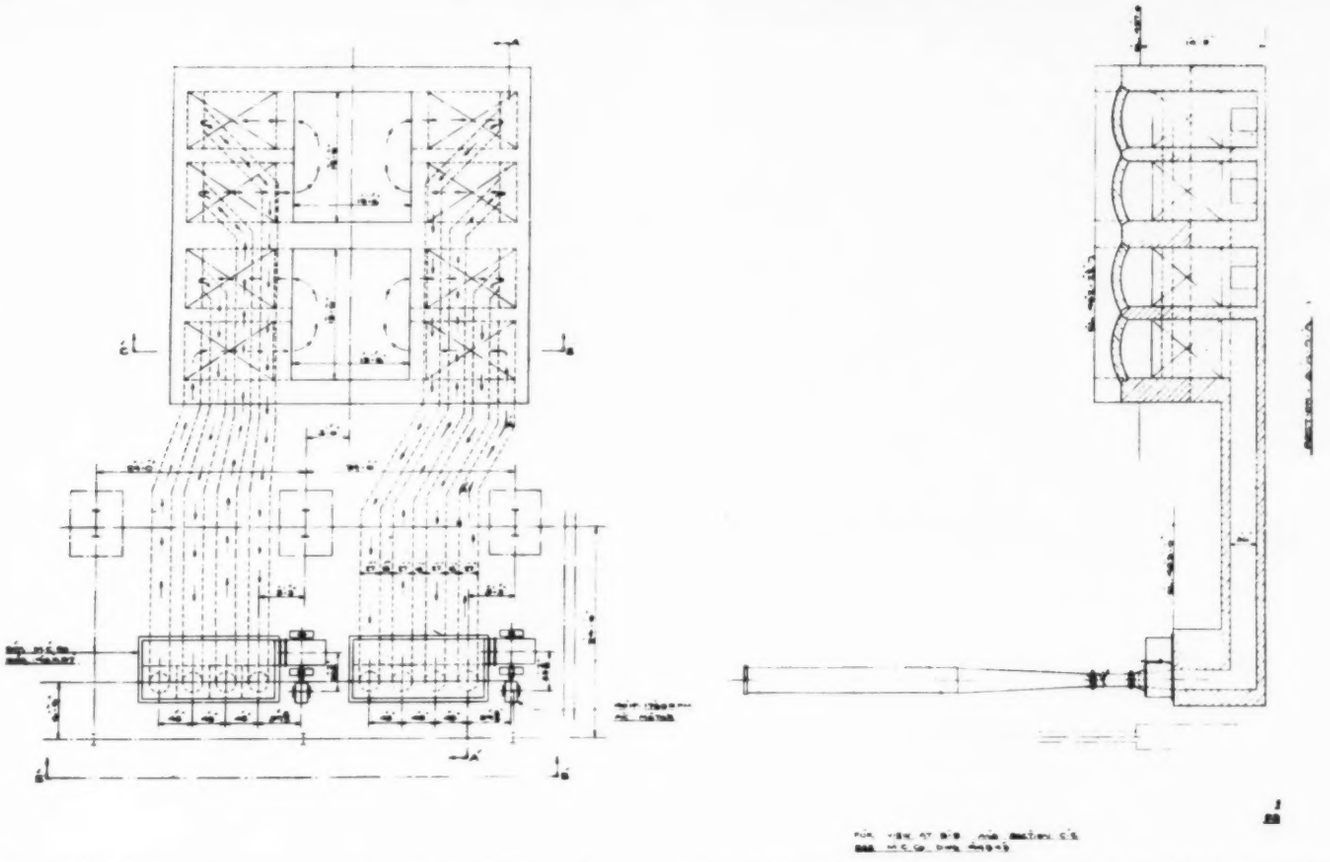
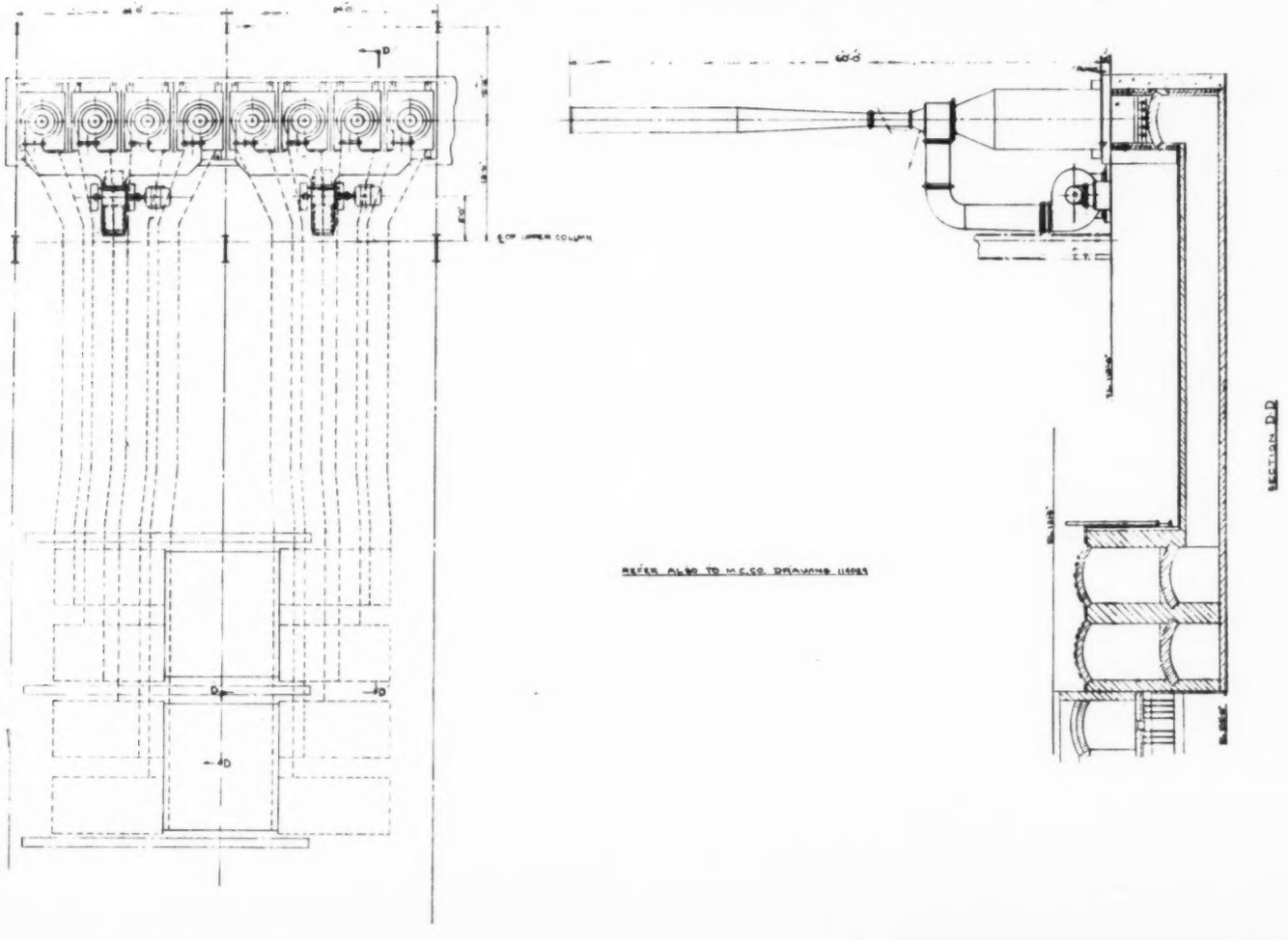


Figure 3 — In order to accommodate larger ingots; the separating walls of pairs of pits were removed, and fuel-air ratio control was installed.

Figure 4 — General layout of enlarged pits in which additional checkers were added in the base of the ejectors.



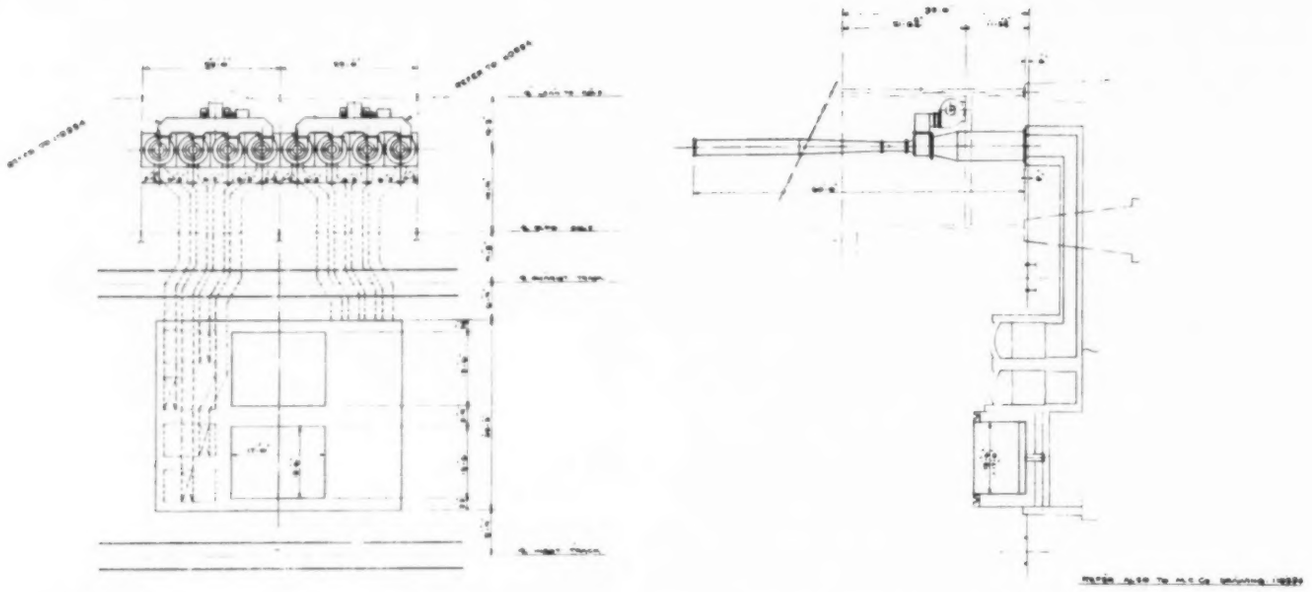


Figure 5 — This pit installation layout is based on the same idea as that of Figure 4 except that natural gas is the fuel.

the soaking pit to the base of the checker without any cooling. The first of these pits was put in operation over 2½ years ago, and to date the checkers are in excellent shape. Figure 7 is a view of the ejector bases and the ejectors outside of the pit building proper. These ejector bases hold all of the checkers for the pits. In the last row that has gone in, in one hole there has been installed silicon carbide brick as checkers for about 25 per cent of the height of each checker chamber. This will give higher air preheat temperatures due to the higher heat absorption capacity of silicon carbide brick.

Figure 8 shows the silicon carbide brick and Figure 9 the clay brick checkers on top of the silicon carbide.

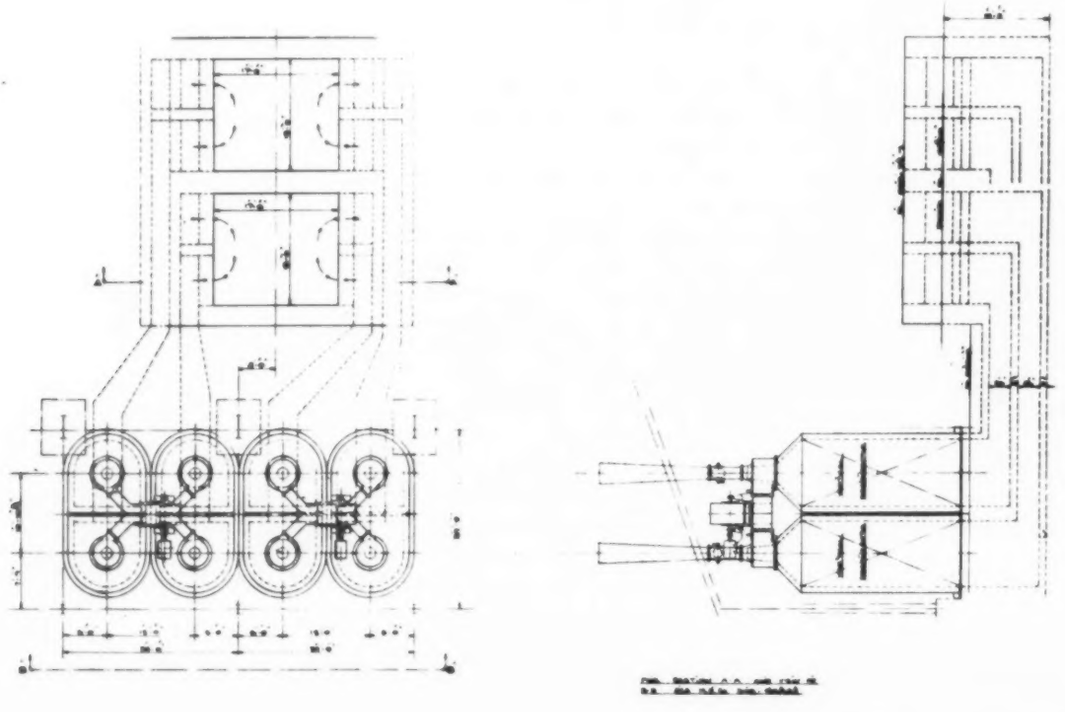
The first two holes of these pits were fired in the same manner as all of those described previously. The next two holes have a slightly different firing method. The double horseshoe firing arrangement, as above, will be used but will be alternated with direct cross firing also. This is all taken care of in the reversal mechanism which is shown on the control panel in Figure 10.

The pits in this installation are fired with either straight natural gas or Bunker C oil. The natural gas is fired against the bridge wall and allowed to roll over the bridge wall into the pit. The Bunker C oil is fired down the uptake against the flow of incoming air.

It then reverses itself and flows up the uptake and rolls over the bridge wall much the same as the natural gas.

Figure 11 shows the layout of a soaking pit using horizontal primary checkers and vertical secondary checkers. The plan view of these pits is shown in Figure 12. This is somewhat of a radical departure from the usual

Figure 6 — In this installation all of the checkers are in the base of the ejectors and none adjacent to the pit proper.



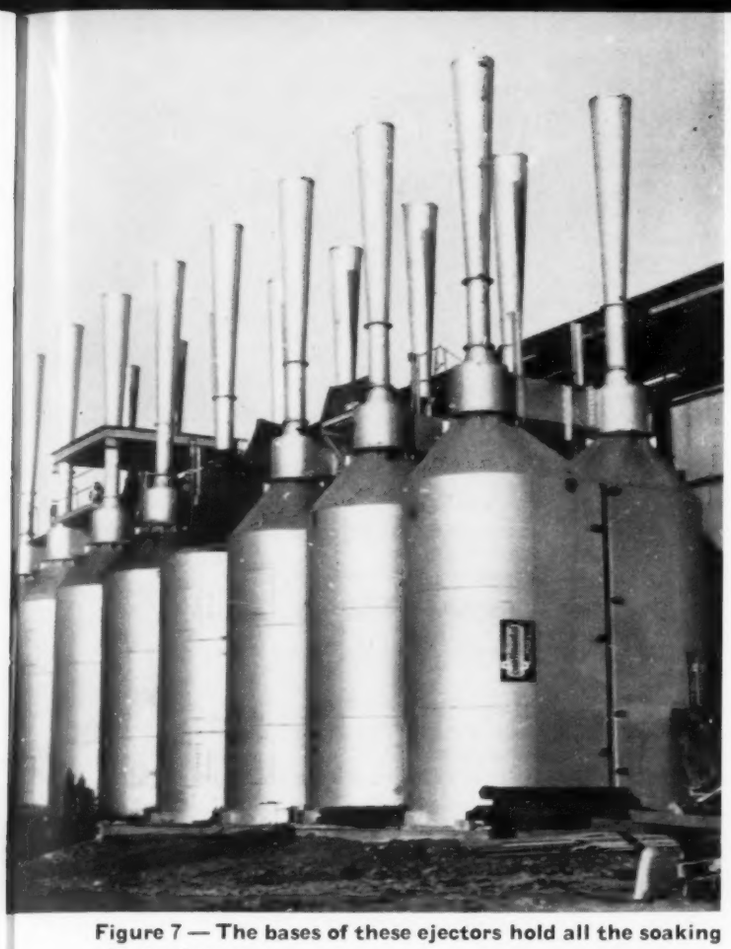


Figure 7 — The bases of these ejectors hold all the soaking pit checkers.

Figure 8 — Silicon carbide brick of the checkers.

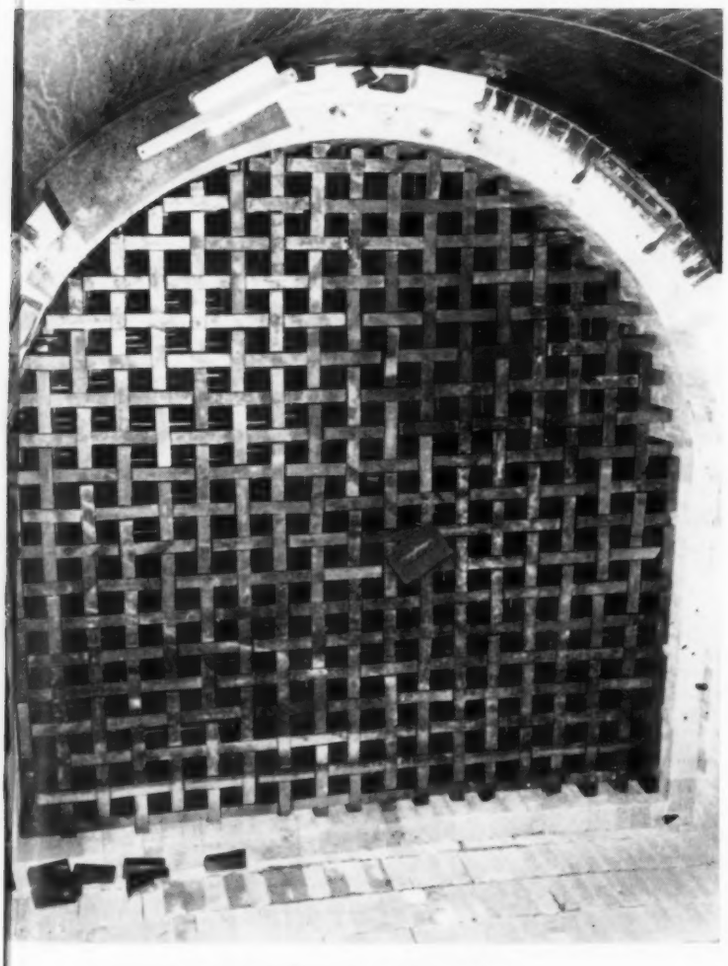


Figure 9 — On top of the silicon carbide are the clay brick checkers.

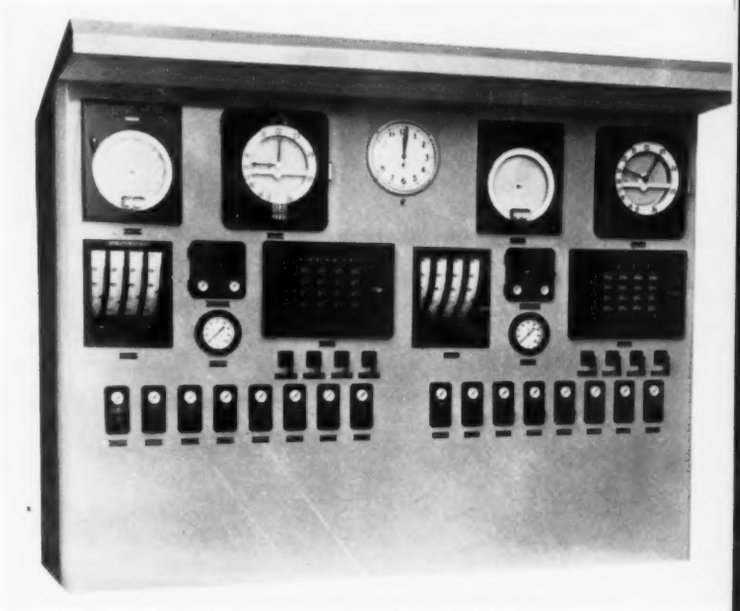


Figure 10 — Control panel for pits of the double horseshoe firing arrangement alternated with direct cross firing.

method of firing a soaking pit and, it is believed to be the first time that it has been used.

The fuel used on these pits is straight blast furnace gas of 88 Btu per cu ft. The temperature of the combustion air entering the pit is in the neighborhood of 2150 F. The burner is located in the throat of the venturi section of the flue between the horizontal checkers and the pit proper. The gas opening is a vertical slot in the side of the throat, which is wider at the bottom than it is at the top. The reason for using this venturi section was to increase the velocity of the incoming air and thereby help pull the blast furnace gas into the pit, inasmuch as the blast furnace gas pressure is very low. Figure 13 shows the control panel for three holes of soaking pits. This control includes furnace pressure control, and there are also means for measuring the combustion air. There are 51 holes fired in this manner.

Figure 14 shows four regenerative pits fired in the conventional cross-fired manner. However, most of the checkers are on one side of the pit, and the checkers have

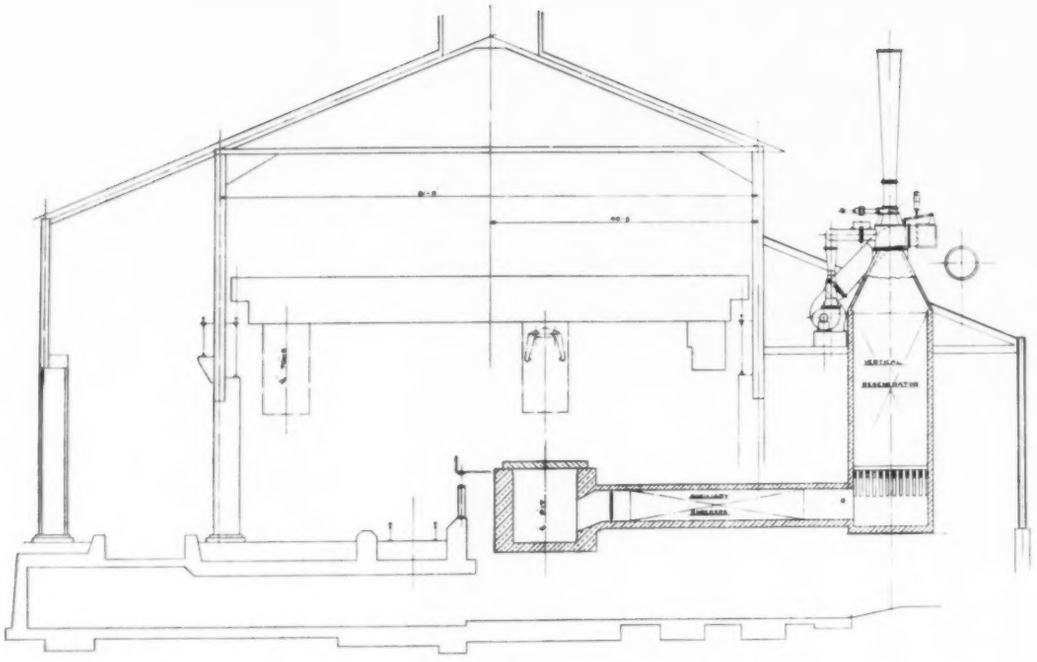


Figure 11 — This soaking pit has horizontal primary checkers and vertical secondary checkers.

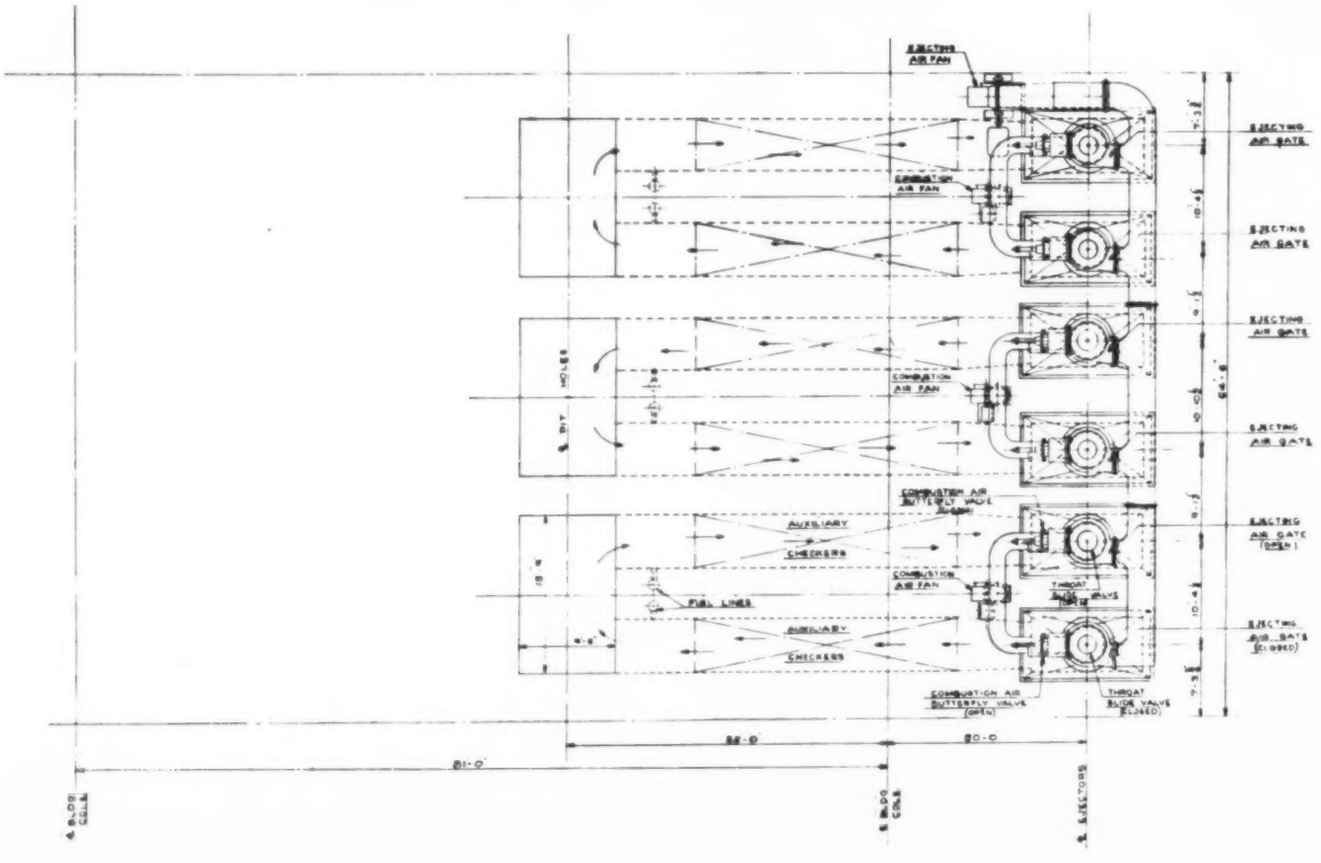
three passes. The fuel used here is a mixture of blast furnace and coke-oven gas of 120-Btu per cu ft heating value. Figure 15 shows the control panel for these pits. This is entirely position control with no fuel-air ratio or furnace pressure control.

Figure 16 shows a cross section of soaking pits with small primary checkers adjacent to the pits proper and rather large secondary checkers in the lean-to of the building. These pits are fired in the conventional cross-fired manner with a mixture of coke-oven and blast furnace gas of 106 Btu per cu ft. There are 16 holes of pits in this installation. The checkers were designed to give a preheated air temperature of 2200 F.

Figure 17 shows these last 16 holes of pits during erection, and Figure 18 shows the completed installation taken from the charging crane.

From the foregoing description of the various soaking pit installations it can be seen that regenerative soaking pits, when properly designed and installed, may be used successfully throughout the entire range of fuels from straight blast furnace gas on up to and including natural gas and Bunker C oil.

Figure 12 — Plan view of the pits shown in Figure 11.



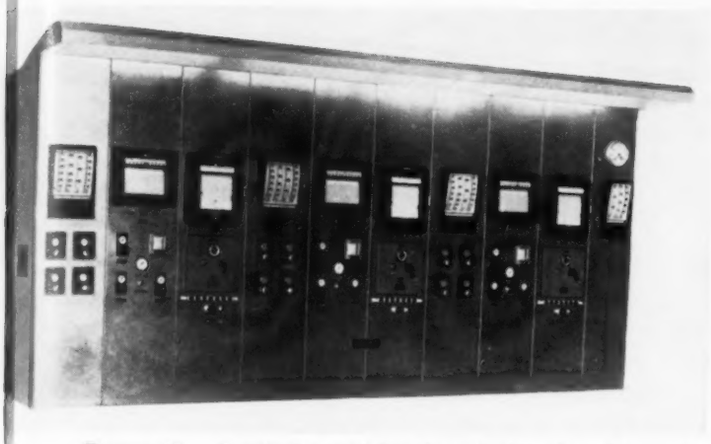


Figure 13 — Control panel for three holes of soaking pits.

Discussion

PRESENTED BY

W. M. BLOOM, Senior Engineer—Fuel, Allegheny Ludlum Steel Corp., Brackenridge, Pa.

HENRY S. HALL, Assistant Manager, Combustion Control Dept., Morgan Construction Co., Worcester, Mass.

GLEN SHARP, Fuel Engineer, Keystone Steel & Wire Co., Peoria, Ill.

WARREN H. NEVILLE, Manufacturers Representative, Nevco, Riverside, Calif.

M. F. DEMSHAR, Superintendent Bloomer and Billet Mills, Acme Steel Co., Chicago, Ill.

J. LEO HAGAN, Fuel Engineer, Utilities Dept., Fairless Works, United States Steel Corp., Fairless Hills, Pa.

HOWARD L. HALSTEAD, Assistant Fuel Engineer, Bethlehem Steel Co., Sparrows Point, Md.

W. M. Bloom: There were some statements in the paper which were not clear to me, and upon which I would like the author to elaborate. The author made a positive statement when he said that "no attempt has been made to apply fuel-air ratio control" to the soaking pits. This statement, it taken at face value, would appear to be a misnomer.

The author has stressed the importance of high preheat air temperatures especially when burning blast furnace gas. A 30 per cent increase in total heat input to the pit per million Btu of fuel input was shown for the use of 2000F preheated air over 500F preheated air. Obviously, this 30 per cent gain in total heat input could be offset completely by firing the pits unknowingly with excess air, if the air-fuel ratio were not controlled, even if only by some simple means.

The simple means or method of fuel-air ratio control is apparently a dial or setter which could be adjusted by the heater. I would like the author to elaborate on this question of fuel-air ratio control. Also, I would like the author to tell us more about his preheat air temperatures. What is the average preheat air temperature from finish-ingot-charge to the ingot-draw period on the pits?

The author has told us, that he has as high as 2150 to 2200F preheated air temperatures. I wonder if this temperature is the same from the beginning of the charge to the final drawing-out of the ingots from the pits, and if it is the same, what is the average ingot track time—the time from finish pour in the melt shop to finish charge in the soaking pit.

Henry S. Hall: We have not applied fuel-air ratio control to any of the soaking pits with our furnace control system.

As I explained in the paper, combustion air is set by the manual setters which operate positioning air cylinders, which in turn either position air slide dampers or butterfly valves. As the pits are reversed from one end to the other, these air slides or butterfly valves controlling the combustion air either open to a predetermined position or close tightly. The setting is made when the pits are first put into operation by checking the flue gas with either an orsat or similar device. We have found that this air setting will last for quite some time, in fact months.

Most of the pits, however, do have a fuel flow control valve which is set by the manual setter for fuel flow and which holds this flow constant.

The air preheat temperatures, which I quoted in the paper, were all taken shortly after the pit was finish charged. On the pits designed for low Btu gas there is quite a volume and, therefore, weight of checker brick, and this holds the average air preheat temperature rather constant. The air preheat temperature when the

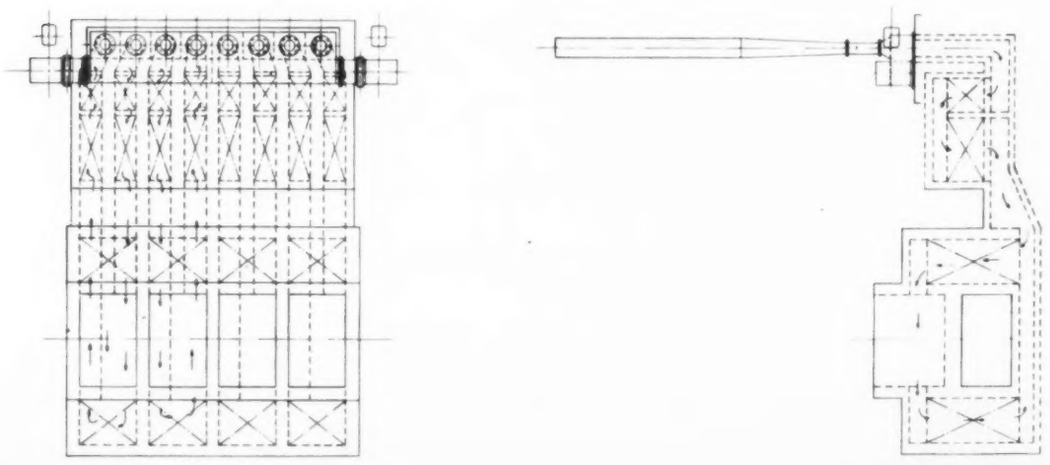


Figure 14 — These four regenerative pits are fired in the conventional cross-fired manner except most of the checkers are on one side of the pit and they have three passes.

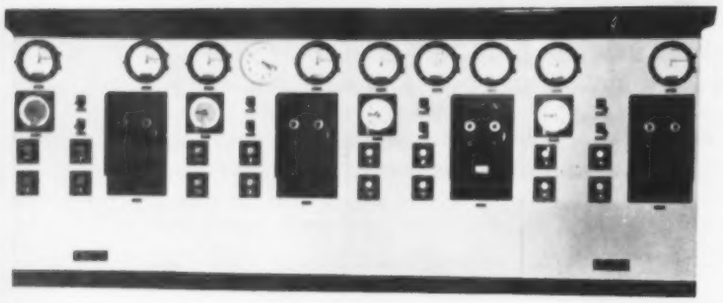


Figure 15 — Control for the pits shown in Figure 14 is entirely position control.

pits are ready to draw is approximately 100 F higher than the figures which were quoted.

Track time averages between two and four hours.

Glen Sharp: At Keystone Steel and Wire Co. we have two such pits in operation with two more nearing completion.

As the author has indicated, various steel companies have installed this type of pit in its several forms for a variety of reasons, more often a combination of them. In our case we sought to make the best use of the special opportunities afforded by an already existing building having a single flexible dimension. We sought also the rather exotic luxury of a checker work designed not so much to utilize the remaining space in a set of drawings as simply to do the job at hand.

In placing the checkers entirely in free space outside the building, we obtained a dividend, since it is already obvious that brick life will, by several times, exceed that to which we have reluctantly become accustomed. Thus far there is only a mellow brown patina to reveal that these brick have been in service 2½ years. We have dared to experiment with silicon carbide checker brick on one of the new holes with the idea of learning whether the extended pay-off will return the extra investment as added preheat. We expect that it will. In connection with checker brick life it is necessary to remember that downtakes and flues are not simply part of the plumbing, so to speak, but working parts of the regenerator, and it is these which take the initial impact of the pit products.

Control apparatus and methods on the operating pits are essentially as described by the author. Fuel flow rate is controlled but neither pit pressure nor fuel-air ratio is controlled directly as such. The control method for the newer holes will differ considerably but any discussion of this is best deferred until its efficacy is demonstrated in practice.

Warren H. Neville: One thing that I would like to point out is that the underfired pits the author is talking about, I believe, are the only pits that are heating 100 per cent on blast furnace gas as of today. Now, someone may correct me on that, but I think that is a fact. I talked to the author directly and I believe he said these are the only pits that he has ever heard of heating on 100 per cent blast furnace gas. Of course, that is due to the high air preheat.

Just in the way of general comment, I would like to say that the hearth coverage of these pits is away above any of the one-way fired pits or any other type pit. Also, the reversal is faster than any of the old style pits.

Henry S. Hall: As far as I know these are the only pits, at least at the present time, using straight blast furnace gas as fuel.

M. F. Demshar: I feel that this area of pit drafts is something that should have been gone into about 50 years ago. Now, I would like to know if it can be done with one-way fired pits. I do not see why not.

The other thing specifically that I am interested in, is the use of straight blast furnace gas. You maintain that an induced-draft helped out on the blast furnace gas pressure.

How do you keep the pit under positive pressure?

Figure 16 — Cross section of pits with small primary checkers adjacent to the pits' proper and large secondary checkers in the lean-to of the building.

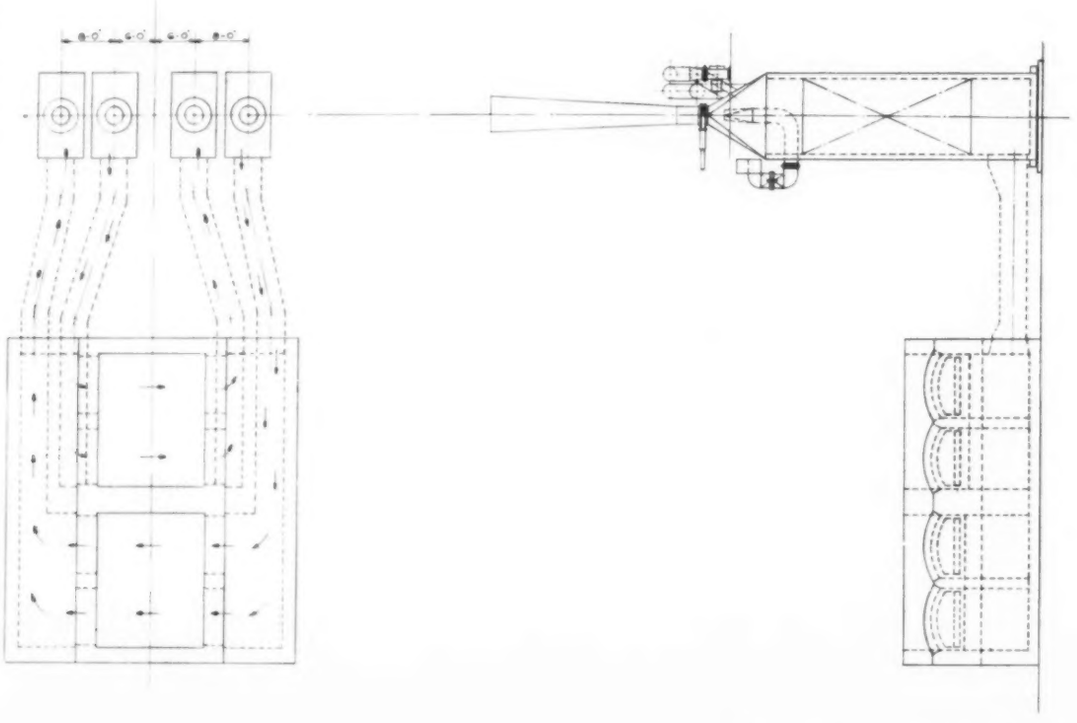


Figure 17 — Pits are under construction.

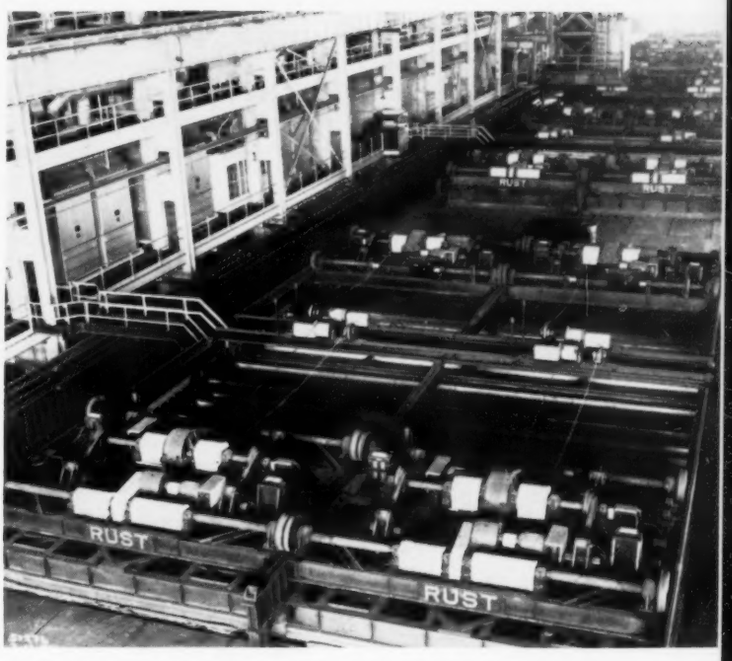


Figure 18 — View from charging crane shows pit installation of Figure 17 completed.

How do you control the infiltration of air?

Another thing, there are all kinds of arguments against this induced draft versus stacks. Maybe you can put it across in a very few words. What is a good selling point to tell people they should have induced draft?

Henry S. Hall: We have furnished quite a few single ejectors for producing draft for one-way fired soaking pits. The ejector simply takes the place of the natural draft stack and you have absolute control of the draft produced by the ejector at all times either by means of variable inlet vanes for regulating the amount of ejection air produced by the ejection air fan, or you can regulate the draft by a damper in the flue or by a butterfly damper in the top of the diffuser of the ejector. The horsepower required for the ejection air fan is usually very nominal.

The advantage that we feel is gained by an ejector on an installation such as this is that you are not dependent upon temperature of the flue gases for producing draft, as the instant the ejection air fan is started you have maximum draft available. Also the draft produced is not dependent upon atmospheric conditions.

The pits are very definitely kept under positive pressure by setting the manual setter for draft control or in some instances by the furnace pressure controller setting.

Regarding the use of straight blast furnace gas and the statement that I made in the paper that the incoming air helped pull the blast furnace gas into the pit is probably best illustrated by Figure 19. This diagram shows the venturi section in the flue. As the combustion air goes through this venturi section the velocity of the air is, of course, increased and due to the laws governing flows and pressures in the venturi section, the pressure at the throat of this venturi section is decreased. This decrease in pressure adds onto the blast furnace gas pressure and in effect helps pull the blast furnace gas into the pit.

J. Leo Hagan: You state that your pits are automatically reversed by a time cycle controller. In a regenerative system the initial flame temperature obtained would naturally be greater than the temperature experienced if the pit would be allowed to fire from the same side for several minutes. What variations are obtained during the course of one reversal on preheat air temperatures, or what is the range of tem-

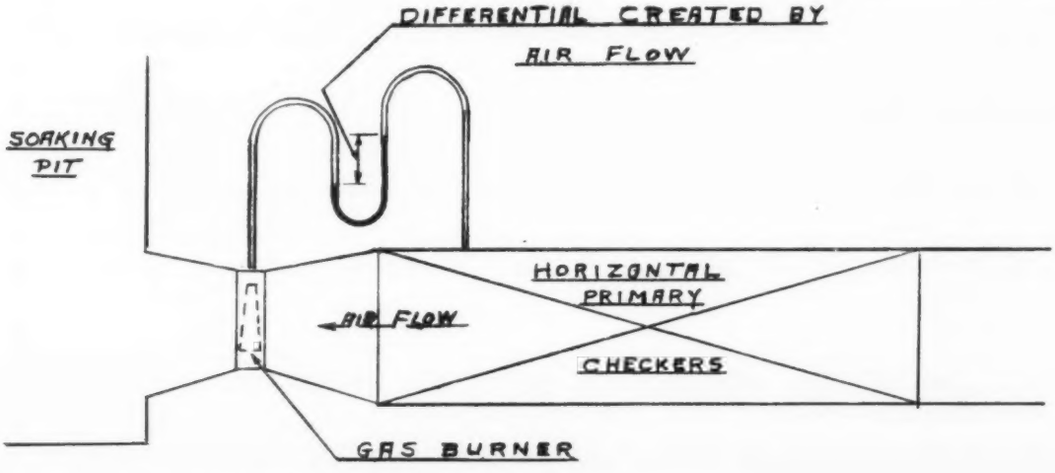


Figure 19 — This diagram shows how the differential pressure is caused by the venturi section in the flue.

perature drop during this cycle on preheat air?

During your reversal cycle, from the time your fuel comes on, until it is automatically reversed, is there a noticeable change of temperature due to a reduction of flame temperature on your temperature recorder?

What is stack exit gas temperature?

In a system such as this, have you experienced any evidence of thermal shock on your checker brickwork?

With this type of on-off control how do you build scale on the surface of an ingot? Once the pit would reach the desired control temperature, the fuel and air would be automatically shut off. The atmosphere in the pit would not be conducive to good scale building.

Henry S. Hall: The only information which we have regarding drop in preheat air temperatures was obtained on the pits as shown in Figures 6 and 7. We took preheat air temperatures in the flues between the pits and the bottoms of the checkers. These were taken with aspirating thermocouples over an entire heating cycle from charge to draw of the pits.

The track time of the ingots was approximately 3½ hours and the heating time 3½ hours. The pits were being fired at this time with natural gas, and the variation of the air preheat temperature ranged between 80 and 120 F.

Answering the second question, we do not notice any change of temperature due to reduction of flame temperature because we are firing enough fuel to raise the temperature above the control point. Inasmuch as these pits use on-off control we do not have a straight line as far as pit temperature is concerned. It must vary above and below the set point of the temperature controller. For this reason when the fuel is off the pits, the temperature is dropping; and when the fuel is on, the temperature is rising. We cannot, therefore, say whether there is any reduction due to flame temperature.

The answer to the third question, of course, depends upon the length of travel through the checker system. On the pits as shown in Figure 3 we have exhaust gas temperatures of 1000 to 1200 F while on pits as shown in Figures 11, 12 and 16 where we have much longer checker travel the exhaust gas temperatures at the tips of the secondary checkers will be in the neighborhood of 600 to 800 F. These temperatures do not vary a great deal from start-charge to draw. There is, of course, a variation during one reversal cycle.

Again, you must remember that there is quite a volume and weight of checker brick in these pits which holds the temperature variations to a minimum.

In answer to question 4, I believe that the comments by Glen Sharp answers this question as well as anything I can say. In the balance of the pits which have been in service less time than the Keystone Steel & Wire Co. pits, we have not noticed any evidence of thermal shock.

Question 5 can best be answered by suggesting a personal observation on the part of Mr. Hagan. The scale that is built is a good dry scale that cleans very easily from the ingots on the first and second passes through the mill.

You must remember, of course, that after the pit is charged and the fuel is put on, the pit is fired continuously except, of course, for reversals, for from 1 to 2½ hours, depending upon the track time of the steel. During this period you have normal pit atmosphere conditions which are the same as any other pit. After this you go to the on-off control when pit temperature reaches the control point and during firing you still have this same pit atmosphere. Of course when the fuel is off and the pit damps up you have no products of combustion in the pit proper. No doubt there is a certain amount of air leakage from the combustion air fan which would drive all the products of combustion out of the pit and give you nothing but air as an atmosphere.

Howard L. Halstead: Concerning the control of air-fuel ratio on soaking pits which are operated with on-off temperature control I believe it is important to have rate-of-flow regulators on both the combustion air and fuel. Even though, when firing, the air and fuel inputs remain constant, regulators should be installed to assure that these flows are maintained constantly at the rate desired. By so doing the desired air-fuel ratio will of course be maintained.

It is true that soaking pits—or any reheating furnace for that matter—can with higher air preheat temperatures perform satisfactorily with fuel of lower calorific value. However straight blast furnace gas will vary in thermal content both in cycles of relatively short duration and the general level of thermal value will change over long periods of time as blast furnace practice changes. For this reason it is desirable to have facilities installed to provide a mixture of blast furnace gas and coke oven or other supplementary gas which will remain reasonably constant in calorific value. ▲

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ASSOCIATION OF IRON AND STEEL ENGINEERS, 1010 EMPIRE BLDG., PITTSBURGH 22, PA.

Development of a New Horizontal-Flow, Plate-Type Precipitator for Blast Furnace Gas Cleaning

by Bengt R. Berg,
Manager,
Precipitator Div.
AB Svenska Flaktfabriken
Stockholm, Sweden

. . . . a new method of introducing and distributing flushing water eliminates former size and height restrictions of this type of precipitator . . . . high collecting efficiencies may be obtained with high inlet dust concentrations . . . .

MANY different methods are used for cleaning blast furnace gas. If limited to only final cleaning of gas, it can be stated that only wet scrubbers, precipitators or combinations of these are used in plants today.

Many types of scrubbers or gas washers have been tested and are in operation. Their general advantages are: low initial costs and small space requirements. One important disadvantage is that they generally have a very high power consumption if a low dust content in the cleaned gas has to be obtained.

Precipitators for blast furnace gas have been built for wet as well as dry collection. As the wet precipitator with its water flushing arrangements is regarded as the most modern type with the best possibilities of being improved so that very low dust concentrations can be obtained, this paper will be limited to discussing only that type.

Theoretically, a precipitator can be designed for efficiencies very close to 100 per cent without increasing the power consumption more than in direct proportion to the precipitator volume (or collecting surface). For practical reasons, however, there are limits giving a maximum size of one single precipitator. With the present requirements of the steel industry, it is often not possible to reach the desired cleanliness of the gas without combining the precipitator with a rather efficient scrubber, used as a pre-collector. Another possibility is to connect two or more precipitators in series. Whether or not this last solution is of interest depends very much on the type and design of the precipitator. Naturally, the precipitators connected in series can be placed within the same shell, but they can still be regarded as separate precipitators as long as they are not connected to each other electrically. Before describing how a precipitator type for this series arrangement was developed, the general relation between precipitator size and collecting efficiency will be discussed.

As known, the collecting efficiency of a collector or precipitator of any kind is defined by the expression $\gamma = 1 -$ (outlet dust content/inlet dust content). When estimating the average collecting efficiency of a precipitator, the following formula is generally used:

$$\gamma = 1 - e^{-\frac{Aw_{av}}{Q}} \qquad (1)$$

where

- A = the size of the total collecting surface of the precipitator,
- Q = gas quantity (volume) per precipitator,
- w_{av} = a factor with the dimension of length per time and which is identified as the *average* migration velocity of the dust particles in the electric field.

It is very difficult to determine the average migration velocity w_{av} beforehand, as it is influenced by, among others, the following factors:

1. Particle size distribution.
2. Strength of the electric field.
3. Density of the charging current.
4. Dielectric constant.
5. Temperature and viscosity of the gas.
6. Agglomeration and re-entrainment properties of the dust.
7. Back-ionization phenomena.

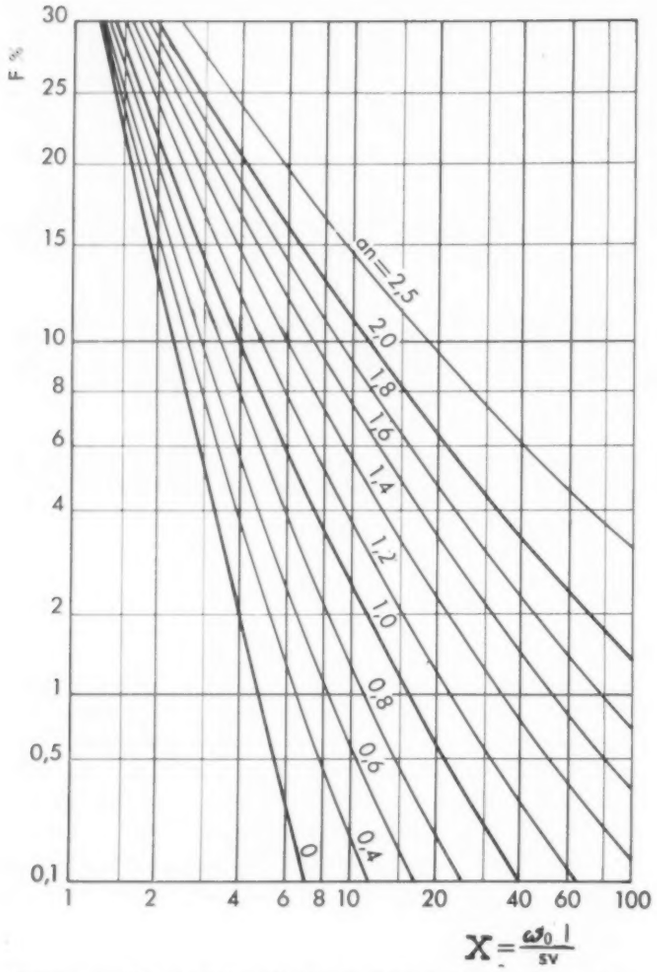


Figure 1 — This family of curves shows the relation between dust loss "F" and quantity "X."

(The last two factors are of special importance in dry precipitators.)

However, experience shows that very often it is the particle size distribution which is of basic importance when calculating the average migration velocity and, thus, also when dimensioning a precipitator for a desired collecting efficiency and a given gas quantity.

THE RELATION BETWEEN PRECIPITATOR SIZE, GAS VOLUME AND COLLECTING EFFICIENCY

Assuming that the fractional migration velocity can be expressed by

$$w(D) = \left(\frac{D}{D_0}\right)^n \cdot w_0 \qquad (2)$$

and that the particle size distribution can be expressed by

$$p(D) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{y} e^{-\frac{1}{2}x^2}\, dx; \quad y = \frac{1}{a} \log_e D/D_0 \qquad (3)$$

which is Drinker's Distribution Function (Logarithmic Probability Function), Allander and Matts (1)* derived an expression giving the dust loss in the precipitator as a function of "n · a" and "X." This expression is as follows:

$$F = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{+\infty} e^{-\frac{1}{2}y^2 - Xe^{nay}}\, dy \qquad (4)$$

where

F = the dust loss from the precipitator (= 1 − γ)
D = size of particle
D_0 = average particle size (50 per cent of the particles smaller than D_0)
w(D) = migration velocity for particles of size "D"
w_0 = migration velocity for particles of average size "D_0"
n = a factor ($0 \leqq n \leqq 1$) determined by the nature of the particle charging
a = particle size deviation
X = $w_0 \cdot 1/s \cdot v$
l = length of collecting field
s = space between discharge electrodes and collecting plates (plate type precipitator is assumed)
v = gas velocity in precipitator
y = variable of integration
p(D) = a function indicating the portion of the studied dust quantity that has a diameter less than "D." This residual distribution function is characterized by the two constants, "a" which is a measurement of the particle size deviation and "D_0" which is the average particle size. The smaller "a" is, the greater the number of particles with sizes within a certain range around D_0. When all particles are of the same size, a = 0.

Allander and Matts have also made a numerical evaluation of "F," as shown in Figure 1.

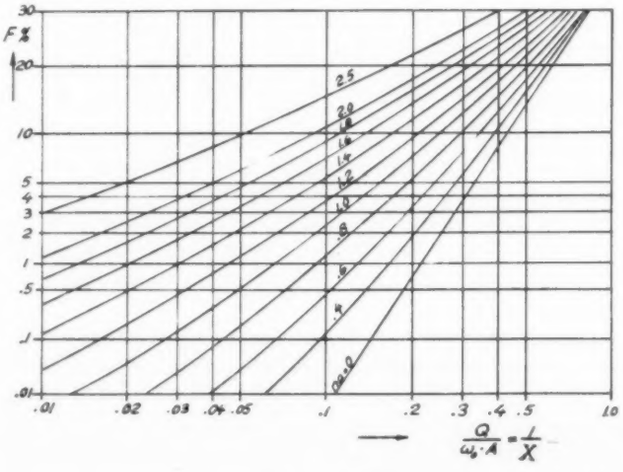
In order to make formula (4) more suitable for our investigation of the relation between precipitator size and collecting efficiency, the nondimensional quantity X is written as follows:

$$X = \frac{w_0 \cdot A}{Q} \qquad (5)$$

where A and Q have the same meaning as previously. The expression (5) is valid for all types of precipitator (plate type, tube, etc.) and the earlier mentioned ex-

* Numbers in parentheses refer to Bibliography at the end of paper.

Figure 2 — Dust loss "F" is a function of the nondimensional specific gas load "Q/w_0A."



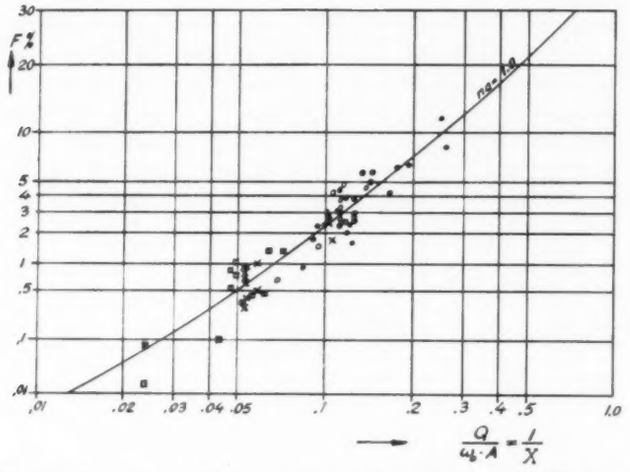


Figure 3 — The points are test data from four different blast furnace precipitators and show "a·n" = 1.0.

pression for X can easily be derived from (5) as a special case for plate type precipitators.

In Figure 2 "F" is given as a function of $(Q/w_0 \cdot A) = (1/X)$, which can be regarded as a *nondimensional* specific gas load. The specific gas load "Q/A" denotes the gas volume per square unit collecting surface.

In Figure 3, test results from four precipitators have been plotted on the same diagram as in Figure 2. The points are scattered, due mostly to the fact that operating conditions have not been the same for all tests. However, it can be seen that formula (4) describes fairly well the dust loss "F" as a function of the gas quantity per collecting surface in nondimensional form —the nondimensional specific gas load.

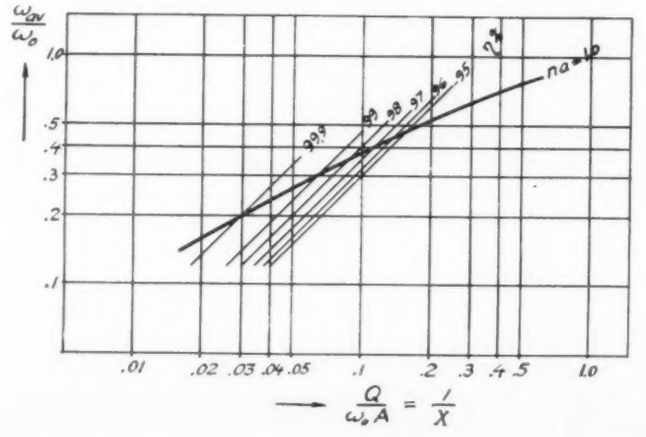
A factor, "w_{av}" was introduced in formula (1), looked upon as being the average migration velocity for all the dust particles in the precipitator. Formula (1) can also be written in the following way:

$$F = e^{-\frac{w_{av} \cdot A}{Q}} = e^{-\frac{w_{av}}{w_0} \cdot X} \qquad (6)$$

It can be interesting to combine expressions (4) and (6), in order to study the variation of the average migration velocity w_{av} as a function of the specific gas load. Then, the following expression is obtained:

$$\frac{w_{av}}{w_0} = -\left(\frac{1}{X}\right)\log_e\left(\frac{1}{\sqrt{2\pi}}\int_{-\infty}^{+\infty} e^{-\frac{1}{2}y^2 - Xe^{ny}}\, dy\right) \qquad (7)$$

Figure 4 — The ratio "w_{av}/w" is a function of the nondimensional specific gas load "Q/w_0A."



The diagram in Figure 3 shows that for the plants tested, the product "a·n" is equal or very close to 1.0. Therefore, the diagram in Figure 4, being the graph of expression (7), has been drawn only for "a·n = 1.0." In this diagram lines are given showing the variation for a number of constant values of the collecting efficiency. It can be seen that the migration velocity decreases considerably with increasing efficiency. This is a very important complication which has to be borne in mind when a precipitator is dimensioned for a high efficiency. In the same way, if the precipitator is equipped with a scrubber acting as a pre-collector, a reduction of the average migration velocity can be expected. This is quite natural, as the very fine particles escaping from a pre-collector are obviously more difficult to collect than the coarser ones that were caught in the scrubber.

BASIC EVALUATIONS AND TESTS

For which efficiencies should a precipitator for blast furnace gas be dimensioned? To answer this question a determination of what dust contents in the cleaned gas can be tolerated must be made. If the blast furnace gas has to be used in gas turbines, recent experiments (2) show that the dust concentration should be of the order of 1 to 4 mg per N cu m (0.0004 to 0.0017 grain per cu ft). "N" means to standard temperature and pressure, and "g" means grams. It has been found that a dust concentration normally varying between 2 and 10 mg per N cu m (0.0009 and 0.0043 grains per cu ft), with a peak value of 15 mg per N cu m (0.0065 grain per cu ft), is too high and causes a decreasing thermal efficiency of the gas turbine, due to dust deposits. From tests made by AB Svenska Fläktfabriken, Stockholm, and from information obtained from iron works in Europe, the dust concentration before the precipitator can be as high as 1.5 to 2 g per N cu m (0.65 to 0.90 grain per cu ft), and occasionally even more. This means that the gas washer in front of the precipitator is mainly intended to be a cooler and that its collecting efficiency is small compared with what is usually obtained in a precipitator. The maximum desirable efficiency of the precipitator should then be around 99.95 per cent. On the other hand, there can be cases where the dust concentration is as low as 0.5 g per N cu m (0.22 grain per cu ft) and where not more than 10 mg per N cu m (0.0043 grain per cu ft) are required. This means a collecting efficiency of 98 per cent. From Figure 3 it can be seen that the required precipitator volume is much bigger in the first case than in the second.

The influence of what has been said above and in the preceding section on the development of modern precipitators for blast furnace gas can most easily be illustrated by referring to an actual case. This will be done in the following. Some of the conclusions reached can, no doubt, be regarded as general for similar cases.

When a new type of precipitator had to be developed to meet with both present and future demands in the iron industry, it was mainly two aspects which had to be studied:

1. The system of construction should be such that a very big unit consisting of smaller internal units could be built.

2. The cleaning of the internal parts by means of water flushing should be perfected, so that the precipi-

tator could be kept in regular operation for long periods without any need for manual cleaning of the internal parts.

The first requirement made it advisable to develop a horizontal-flow precipitator which, according to preliminary investigations, could be expected to be less expensive and less complicated than a vertical-flow precipitator, especially if it was to be made up of more than two independent precipitator zones or sections in series. Regarding point 2, the cleaning, it was not considered possible from the beginning to judge which type of arrangement of water sprays would be the best. Only experiments with full-scale units can give any information on this point.

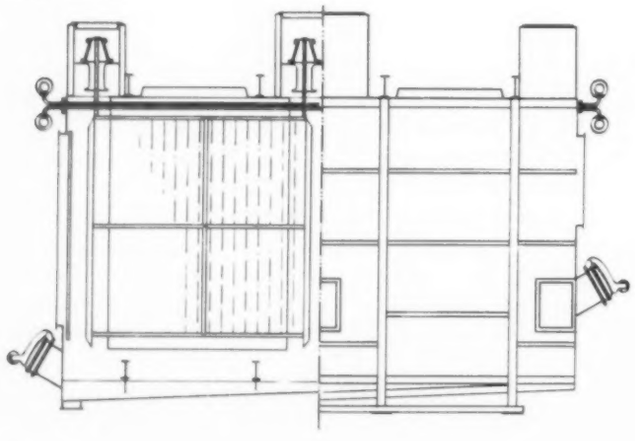
In order to obtain basic information regarding migration velocities that can be expected in full-scale units, collecting efficiency tests were made on a pilot precipitator consisting of only one gas passage with the dimensions of the collecting electrodes, height x length, of about 4.5 m x 3 m (15 ft x 10 ft). The pilot precipitator had a gas washer in front and was equipped with flushing arrangements on the top of the collecting electrodes. These were arranged so that the collecting electrodes could be flushed continuously. Furthermore, there was a possibility of flushing the discharge electrodes intermittently.

The tests with the pilot precipitator showed that it is possible to obtain comparatively high migration velocities as compared with what can be obtained in dry precipitators. During the tests the precipitator could be kept completely clean. The discharge electrodes were kept clean without any intermittent flushing. Although the results obtained with the pilot unit could not be regarded as applicable for a full-scale unit in continuous operation over a long period, it was decided that the first full-scale units should be equipped with flushing arrangements of the same type as in the pilot precipitator.

EXPERIENCE WITH THE FIRST TWO FULL-SCALE UNITS

The design of the first full-scale units which were built is shown in principle on Figures 5 and 6. The collecting electrodes were made of plane steel plates measuring approximately 1.5 m x 4 m (5 ft x 13 ft). Two plates formed one zone of the precipitator. The precipitator was designed with two independent zones,

Figure 5 — This is a longitudinal section of the first full-scale units.



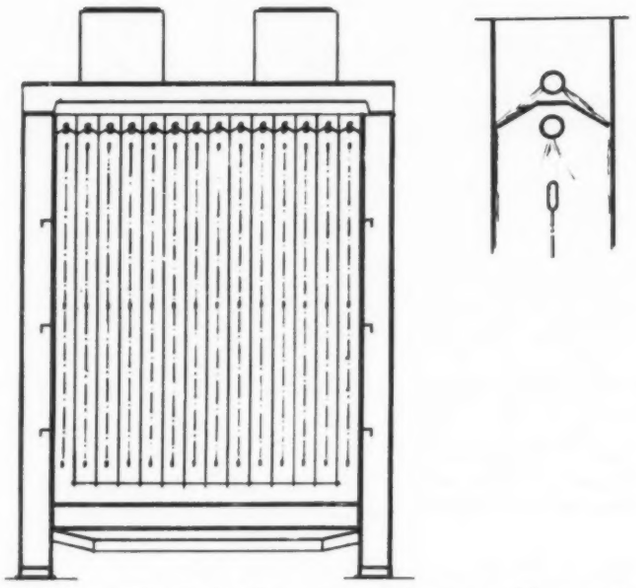


Figure 6 — The first full-scale units' cross sections were as shown.

which means that each precipitator could be regarded as two separate ones built into the same chamber.

The discharge electrode systems, consisting of discharge electrodes and frames for the suspension of these, were hung in porcelain insulators placed in high-voltage chambers on top of the precipitator. As discharge electrodes, thin threads with a diameter of about 2 mm (0.08 in.) were used. The water flushing systems were arranged as shown in Figure 6. On top of each gas passage two tubes were placed lengthwise. Both tubes were perforated in a special manner so that the flushing water would be evenly distributed lengthwise over the precipitator. The lower tube was intended for intermittent flushing of the discharge electrode system. The upper tube sprayed water continuously on the collecting electrodes, and special vanes were made in order to distribute the water toward the plates, preventing water from this flushing system from wetting the discharge electrode system.

The precipitator was equipped with a deairing system in order to ensure starting-up without risk of explosion. At the inlet of the precipitator a screen of gas distribution baffles was placed.

Two full-scale units were built. One was placed at Domnarfvets Jernverk, Sweden, where the blast furnace produced iron with a low silicon content (lower than 0.5 per cent). The other full-scale unit was erected at Oxelösunds Järnverksaktiebolag, also in Sweden. At this latter plant various qualities of iron are produced, from martin iron with a silicon content of around 0.7 per cent to iron for foundries with a silicon content of about three per cent.

When the precipitators were started, considerable difficulties were encountered. Most of the trouble originated from insufficient cleaning of, in particular, the discharge electrodes. The trouble caused by dust build-ups can be summed up as follows:

1. Dust build-ups were easily formed on the thin wire electrodes.
2. Water droplets flowing down along the discharge electrodes had a tendency to jump out against the collecting electrodes and cause flash-overs.

3. On half of the height of the discharge electrode system, the wires were suspended in a special frame. This frame stopped the water from reaching the lower electrodes, for which reason dust very easily built up on these.

4. Water drops falling on the middle frame splashed off against the collecting electrodes and caused flashovers.

The above-mentioned difficulties were overcome by omitting the frames in the middle and exchanging the thin wire electrodes for flat iron electrodes, which were erected in such a way that they had their greatest stiffness in the direction against the collecting electrodes.

Regarding the collecting electrodes, experience showed that it was very difficult to get them wetted evenly. If the film of water was a little bit thinner at one point, dust started to build up slightly there. Sooner or later the water flow was divided into two streams, one on each side of the dust build-up. As soon as this happened, the dust deposit grew very rapidly until it reached such a thickness that the precipitator operation became too unsteady and some sort of manual or chemical cleaning was required.

The small holes in the tubes which distributed water along the precipitator passages clogged very easily, and the water had to be very clean if clogging was to be avoided. When the intermittent flushing system was in operation, the current in the precipitator had to be decreased very much. This meant, of course, that the collecting efficiency of a section was decreased considerably during this cleaning.

In order to improve the cleaning of the collecting electrodes, as well as of the discharge electrodes, it seemed to be necessary to arrange so that the water and the dust were mixed together very thoroughly on all surfaces where the dust was normally collected or where, for other reasons, it could form deposits. As it had been found in practice that distributing the water evenly over the collecting surfaces by mechanical means was a very difficult task, the idea was formed that it should be distributed by means of the same electrostatic field as that which collected the dust. In this way, the dust would be completely suspended in the water as soon as it had been collected.

Tests were made to see if the above idea was correct. During these tests banks of spray nozzles were placed in front of the first section and in the inspection passage in the middle of the precipitator in front of the second section. The nozzles used were of ordinary centrifugal type but with a special shape so that a very fine mist of water drops could be created without using a very high water pressure. The dimensions of the jet were rather big, so that the risk of clogging of the nozzles would be reduced. This arrangement gave an almost satisfactory result at the plant where iron with a low silicon content was produced (Domnarfvet) but it was still not sufficient for the precipitator which treated gas from the furnace producing iron with a high silicon content.

At Oxelösund the dust concentration in the gas entering the precipitator was measured at various operating conditions of the blast furnace. A rather interesting connection was found between the silicon content in the iron produced and the dust concentration in the gas after it had passed a dust catcher, a cyclone and a scrubber. The results of these tests can be found in Figure 7. The fact that the dust concentration in the gas increases so rapidly when the silicon content is above 2 per cent can be explained in the following way:

When the gas is passing through the dust catcher, the cyclone and the scrubber, practically all coarse particles are collected. Of the remaining fine dust, only a small fraction originates from the layers above the slag level in the furnace. The main part of the fine dust remaining in the gas after it has passed the cooler has been formed by evaporation and subsequent oxidization and sublimation of, in particular, the silicon in the molten iron. This explains why the curve obtained from the results shown in Figure 7 has the same general form as the curve of the silicon vapor pressure as a function of its concentration in the liquid phase. The main reason why the cleaning of the precipitator in Oxelösund was a worse problem than in Domnarfvet seems to be that the precipitator had to operate at very high dust concentrations for periods of considerable length.

At dust concentrations above one grain per cu ft at normal temperatures and pressures, the cleaning of the discharge and collecting electrodes in the precipitator in Oxelösund was insufficient, so that the precipitator had to be cleaned manually about once every three months. When introducing nozzles with horizontal sprays before each section, the cleaning was improved but, as mentioned, it could not be regarded as satisfactory. Adequate cleaning could not be achieved until the last stage in the development series was completed.

DEVELOPMENT OF AND EXPERIENCE FROM THE FINAL DESIGN

From the tests with the full-scale units developed as stage two, the following conclusions could be drawn:

1. The principle of introducing water droplets into the gas in such a way that they are collected simultaneously with the dust seemed to be correct.
2. A fairly good distribution of the water covering the collecting electrodes, as well as the discharge electrode system, had been obtained with the nozzles spraying in a horizontal direction before each of the two stages.
3. The flushing of the discharge electrode system by means of water sprays from the lower tubes situated above the frames of the system was not satisfactory, as the collecting efficiency of the section was lowered considerably during the flushing.
4. Dust deposits could be formed on the collecting electrodes when the film of water covering the electrodes for some reason was divided into two or more separate streams.
5. The phenomena mentioned in point 4 could, after the insertion of nozzles in front of the sections, only be found at the end of the collecting electrodes, which place the water droplets from the spray nozzles could not reach, as they were collected by the electrostatic field earlier.

For the final stage it was decided to arrange the cleaning in the following way:

Spray nozzles should be placed on top of each precipitator section, as well as in front of it, so that a mist of water droplets could be introduced from two directions at right angles to each other. Furthermore, the

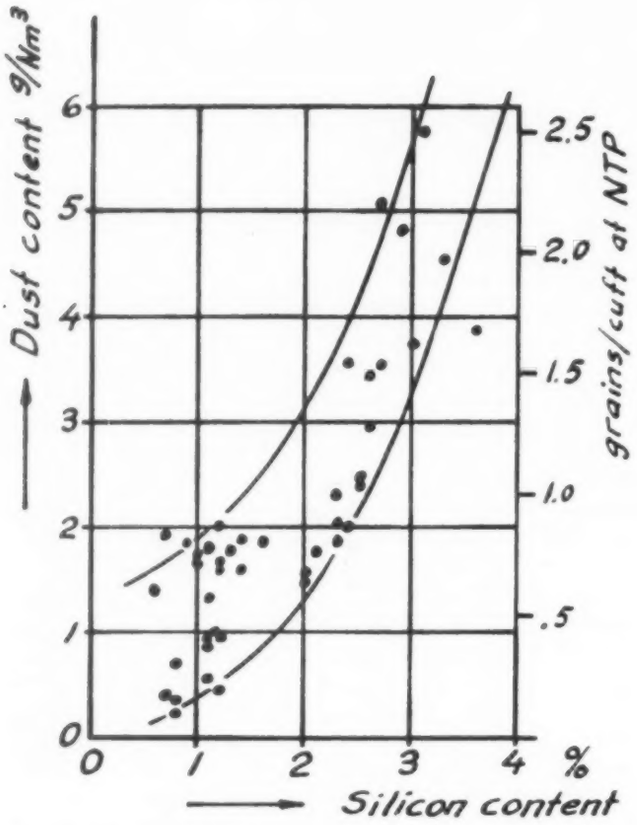


Figure 7 — These curves were plotted from operating conditions of a blast furnace, and show silicon content of the iron and dust concentration in the gas after it has passed a dust catcher, cyclone and scrubber.

collecting field of the first zone (and the second in precipitators with three or more independent zones) should be divided into two parts with spray nozzles with a horizontal spray direction in between. The two parts, however, should still belong to the same electrical section.

In this way, the difficulties mentioned above under points 3 to 5 should be avoided.

When the precipitator plants at Domnarfvet and Oxelösund had to be extended, the new precipitators were built with flushing arrangements as described above. The starting-up of these precipitators, as well as experience from about four years of operation, show that the principle applied when designing the cleaning device was a successful one. Before this design could be regarded as completely developed, some additional minor adjustments and improvements had to be made. Thus, the number of nozzles at different places in the precipitators had to be adjusted, so that at places where most of the dust was collected most of the water was sprayed.

When such a great number of water nozzles are built into a precipitator containing poisonous gas, the cleaning of the nozzles, if required, would be a very complicated task if it were done from the outside without stopping the precipitator for inspection. Therefore, it was emphasized that the nozzles should be kept clean and be of such a material that they would not be destroyed by corrosion. It was possible to find a geometrical form of the nozzles and a size of the water jets which allowed the use of water containing a considerable amount of impurities. The pressure drop over the nozzles was around 1.5 to 2 kg per sq cm (21.5 to 28.5 psi.). After testing various materials for the nozzles, it was also possible to find a suitable one.

After all these adjustments had been made, it was found that the precipitators can be in operation without shutdowns for 12 months or more. At inspections after such periods, practically no dust deposits have been found in the precipitators. After the successful results with the latest design, the water flushing arrangements in the precipitators built as stage two have been altered to be in accordance with the new design.

The precipitators have been tested at various specific gas loads, and the results of these tests are those shown in Figure 3. Collecting efficiencies above 99 per cent can easily be obtained and dust concentrations in the clean gas below one mg per N cu m (0.0004 grain per cu ft) have been reached. The inlet dust concentrations for which the precipitators have been tested are shown in Figure 7.

The flushing of the different sections can be arranged either to operate continuously or intermittently following a predetermined program. Near the outlet of the precipitator less water is required, as very little dust remains in the gas and is collected there. The spray nozzles could be arranged and adjusted in such a way that water flushing can be effected with remaining high voltage on the discharge electrode systems. This means that

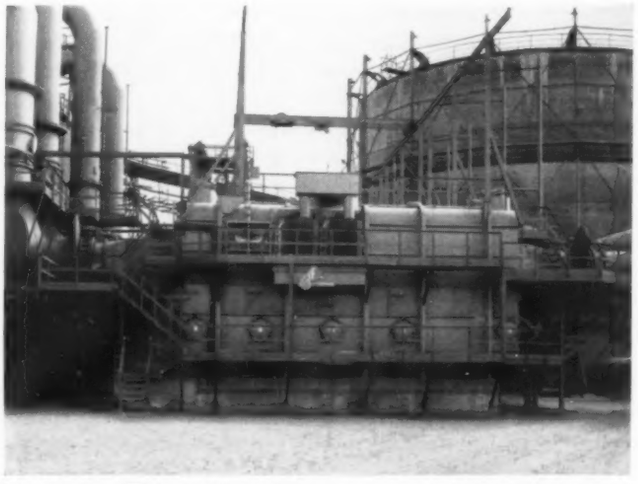
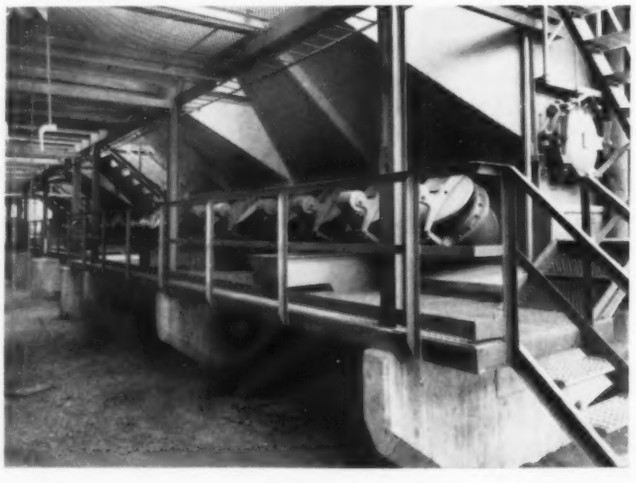


Figure 8 — This is blast furnace gas precipitator plant at Domnarfvets Jernverk, Sweden.

Figure 9 — Shown is the arrangement of the inlet ducts, explosion doors and water locks in the precipitator plant at Domnarfvets Jernverk, Sweden.



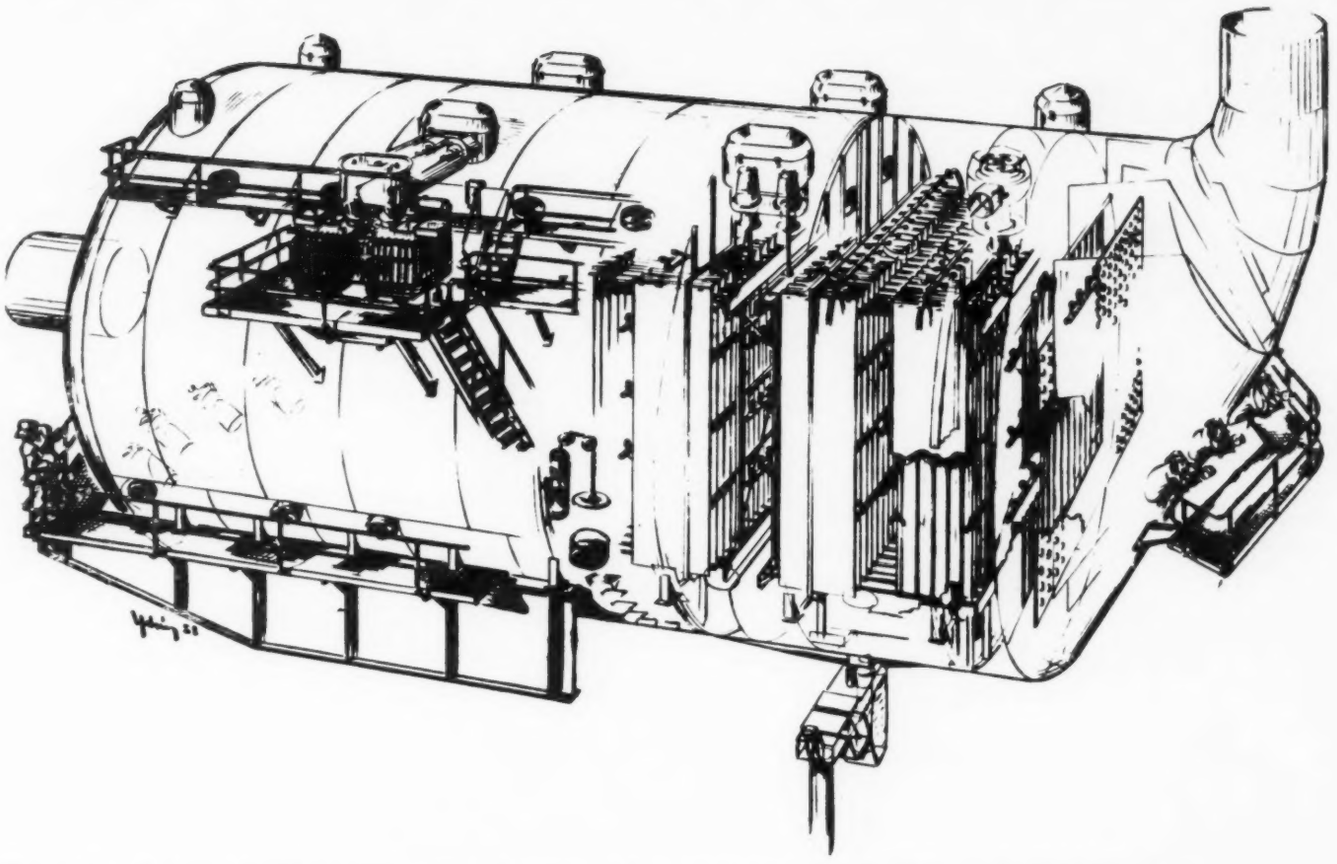


Figure 10 — Designed for high-pressure blast furnaces, this precipitator has three different electrical sections.

the efficiency of the precipitator is not lowered during the flushing periods.

Today, 11 different precipitator chambers of the described type are in operation at four different works and additional ones are under construction in Sweden, Germany, Belgium and Italy.

Figures 8 and 9 show the gas cleaning plant at Domnarfvets Jernverk, Sweden. The plant contains six different precipitator chambers arranged as three twin-chambers with a common wall between.

ADAPTATION OF HORIZONTAL-FLOW PRECIPITATORS FOR PRESENT AND FUTURE NEEDS

In recent years the iron and steel industry has been getting more and more interested in operating blast furnaces with high pressures (of the order of one kg per sq cm gage pressure, i.e., 14 psi). In order to enable the precipitator shells to withstand this pressure without a very big increase in weight, these have been made with a circular shape. Generally, a vertical-flow tubular precipitator is looked upon as being the most suitable one for a cylindrical shell. A vertical-flow type precipitator, furthermore, takes less space, which is very important in some cases. However, if very big gas quantities have to be treated and if the desired dust concentration in the clean gas is very low, there can be practical difficulties in building vertical-flow precipitators big enough and in arranging several independent zones in series. The horizontal-flow plate type precipitator, however, can, as mentioned earlier, easily be divided into several zones and, thus, be made with a very big collecting surface. It can also, without difficulty, be built into a cylindrical shell, as shown in Figure 10, which also shows the principal design of the precipitator type, the development of which is described earlier. When it is necessary to increase the collecting surface of a precipitator, it is cheaper to do it by increasing the height of the collecting electrodes than by increasing the number of gas passages. However, with increasing height of the electrodes, the problem of cleaning them gets worse, as a water film flowing down along a vertical surface very easily splits up into several streams, leaving almost dry parts in between. On these dry parts the dust then easily builds up. This fact, together with the possibilities of stiffening the discharge wire system, limits the possible height of one section in a vertical-flow precipitator. In the horizontal-flow type, the arrangements for flushing the electrodes from two directions at right angles to each other remove that limitation on height. The only limitation on height which is left is that caused by the need for stiffening the collecting and discharge electrodes. When the precipitator is sectionalized lengthwise, however, good possibilities exist of stiffening both types of electrodes, so that it can be expected that the maximum height of the collecting electrodes in horizontal-flow precipitators is greater than the corresponding maximum for vertical-flow precipitators.

What is mentioned above probably constitutes the main reasons why the general trend in Europe is to use horizontal-flow plate type precipitators. This trend can be seen in literature (3) where horizontal-flow precipitators with several sections are regarded as the most modern design.

ELECTRICAL EQUIPMENT

The precipitators tested as stage two had mechanical rectifiers. The latest precipitators, however, have selenium rectifiers, the latter having saturable reactor control.

Compared with dry precipitators, the flash-over frequency in a wet precipitator is high, even at normal operation. Ample protection of the high-tension transformer and the rectifier is, therefore, required. When mechanical rectifiers are used, this protection is obtained with damping resistances placed in series with the low tension wiring, between the rectifier and the high-tension cable and between the cable and the precipitator. When selenium rectifiers are used, it is possible to use a saturable reactor connected to the low tension core. The saturable reactor can be dimensioned in such a way that the characteristic of the complete unit, reactor-transformer-rectifier, is very suitable for precipitator operation. Tests have also been made on wet precipitators with the saturable reactor controlled power packs governed by an automatic device which is sensitive to the frequency and intensity of the flash-overs. As it is normal for the frequency of sparking in a precipitator of this type to be very erratic and as this *normal* phenomenon does not cause any measurable variation in collecting efficiency, no difference was found in the precipitator performance with or without automatically governed saturable reactor. On the other hand, with a power pack without the type of damping that can be achieved with a saturable reactor, improvements can be expected if an automatic governor is used.

Some of the precipitators which are in operation at the moment have the rectifiers connected directly to the different precipitator zones. Others are connected by means of high tension cables. The former arrangement has proved to be better for the following reason:

The high tension cable acts as a capacitor, in which a considerable amount of electric energy is stored. When a spark is produced in the precipitator, this capacitor is discharged. The current flowing through the cable during the very short moment when the spark is in existence is of an order of magnitude of 1000 to 10,000 times the normal current, and if the cable is not amply protected by damping resistances, it can be destroyed.

Figures 8 and 10 show how the power packs have been connected directly to the precipitator sections.

SUMMARY

The main problem in connection with precipitators for blast furnace gas is the cleaning of the internal parts. The cleaning is done by means of water flushing. The method of introducing the water and distributing it within the precipitator is of vital importance. With suitable arrangements for this, precipitators can be made bigger and higher and a steady operation without shutdowns can be obtained.

If very low dust concentrations in the clean gas are to be obtained for large gas quantities, the horizontal-flow plate type precipitator seems to be the best solution, as its design gives possibilities of placing several independent electrical sections in series. Metallic rectifiers can, if combined with control and damping devices containing saturable reactors, be made very suitable for blast furnace gas precipitators.

BIBLIOGRAPHY

1. "Einwirkung der Korngrössenverteilung auf den Abscheidungsgrad von Elektrofiltern," by C. Allander and S. Matts, Staub (1957) Heft 52.
2. "Zwei Gasturbinengruppen für ein belgisches Hüttenwerk," by A. Jaumotte, Stahl u. Eisen 78 (1958) No. 10, May 15.
3. "Die Entwicklung der Hochofengas-Reinigung in den letzten zehn Jahren," by K. Guthmann, Stahl u. Eisen 73 (1953), No. 5, Feb. 26.

Discussion

PRESENTED BY

J. MURRAY, Blast Furnace Consultant, Republic Steel Corp., Chicago, Ill.

N. L. GIURICICH, The Buell Engineering Co. Inc., New York, N. Y.

C. K. GORDON, Design Section Supervisor, Arthur G. McKee & Co., Cleveland, Ohio

J. Murray: I was particularly interested in the part describing the injection of finely divided water into the gas stream which helped in keeping the electrodes and plates clean. My interest in precipitators is the cleanliness of the gas for use in coke ovens and hot blast stove firing.

While I think the author's design is excellent and no doubt performs well in cleaning the gas, we have already spent large sums of money to install our present many vertical tube precipitators and must make them work efficiently. We recently blew in a furnace that was partially relined, the dust catcher cleaned out and the other portions of the gas cleaning system put in good shape. Daily samples are taken of the gas from the precipitators and analyses show it to contain 0.0006 grain of dust per cu ft. This, we think, is excellent gas and can be used any place, stoves, coke ovens or gas engines. At another plant where the furnace has been in operation for quite a few years with the dust catchers and wet washers partially plugged, the precipitator gas contains about 0.005 gram per cu ft which is still good for coke oven firing. Generally, our precipitators at the plants with normal care will give gas of about the same cleanliness.

At Buffalo, one furnace has been rebuilt, a washer and precipitator installed. When put into operation, we have hopes of getting a very clean gas from this installation.

I would like to ask this question: If we would install fog sprays in the gas stream before our vertical tube precipitators, do you think the moistened gas would help keep the electrodes and tubes cleaner with less flushing required?

N. L. Giuricich: Provided the water flush systems already incorporated in tubular type precipitators are operating satisfactorily, we believe the addition of fog sprays before the precipitator would be of little value.

C. K. Gordon: What is the approximate cost of a 150,000-cfm capacity axial precipitator, in dollars

per cfm delivered in the United States based on the two precipitators mentioned in the paper? One would be a 99.95 per cent efficiency precipitator with an inlet loading of 0.65 to 0.9 grain per cu ft giving an outlet loading of 0.004 grain per cu ft and this is suitable for gas turbine use. The other precipitator would be a 98 per cent efficient precipitator with the same inlet loading but with an outlet loading of 0.015 grain per cu ft. This would be satisfactory for use in blast furnace stoves and boilers. I am also interested in knowing what the approximate water consumption and power consumption is for a 150,000-cfm precipitator.

The second question is how is the slurry removed from the axial flow precipitator since it is a long horizontal cylinder without sludge hoppers? The precipitators that I am acquainted with in the United States are the tubular type and the plate type. The tubular type has a sludge cone at the bottom. The plate type has multiple hoppers. I believe both require periodic blowdown to keep them from clogging up.

The third question has to do with plate thickness. It was stated that the plates were plane and 5 ft wide by 13 ft high. I wondered how thick they are. I understood that the discharge electrodes are the ribbon type but the thickness was not stated. Also, how difficult is it to remove the electrodes from the precipitator when they are broken?

N. L. Giuricich: The delivered cost per cfm of a precipitator for 99.95 per cent efficiency is approximately $3.00; and for a 98 per cent unit this is approximately $1.60 per cfm. Please keep in mind that the higher efficiency precipitator is more than twice the size of the 98 per cent unit.

Water consumption of the 99.95 per cent precipitator would be approximately 1500 gpm, maximum. For the 98-per cent unit, water consumption would be approximately 900 gpm.

A precipitator of the horizontal, cylindrical type has a sloped bottom for removal of the collected slurry. Spray nozzles can be included to keep the slurry agitated, if required. However, this has not been found necessary since the quantities of water sprayed into the precipitator are sufficiently great to prevent any build-up of dust.

The collecting electrode plates used in this type of precipitator are approximately $\frac{1}{4}$ in. thick.

The emitting electrode wires are of the ribbon type and are approximately $\frac{3}{16} \times \frac{5}{8}$ in. They are so mounted in the precipitator that they will not deflect in the electric field and reduce the spacing between the wires and the collecting plates, i.e., the widest dimension of the emitting wires is perpendicular to the gas flow.

The collecting electrode plates cannot be removed through the manholes provided in the precipitator shell. However, the construction of the plates is such that their removal is never anticipated, as they will last as long as the precipitator. If for any reason it was required to remove the plates, it would be necessary to take the connecting flues off to remove them. ▲

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by David Hugh Samson,
Project Engineer,
Dominion Foundries & Steel Ltd.,
Hamilton, Ontario, Canada

. . . . the work and planning preliminary to changeover was so complete that only the replacing of the old mill and pinion stand by the new ones on new foundations in the same location remained to be done—thus only a 15-day mill shutdown was required . . . .

THE purpose of any manufacturing operation is to make money, whether the product is steel or newspapers, automobiles or furniture. In order to make money, it is usually necessary to keep production equipment operating with a minimum of interruption. This is especially true in the production of steel, where the huge capital investment and relatively low gross return are difficult to reconcile.

When the decision was made at Dofasco to replace the old 2-high mill with a modern 2-high reversing slabbing mill, the problem of maintaining production was a major factor. All hot and cold rolled products first pass through the 2-high mill so that an extended shutdown of this mill would seriously affect all rolling operations.

In order to reduce the mill shutdown to the minimum, a carefully planned construction program was set up. The first part of the program called for as much work as possible to be done ahead of the shutdown. This work included the replacement of the mill approach and runout tables, the installation of new electrical equipment and off-site assembly of the mill. A novel feature of the electrical installation was the use of the new equipment to drive the old mill, first by temporary wiring from the new main motor-generator set, then from the new mill motor by means of a 24-ft temporary spindle.

The second and major part of the construction program was the 15-day shutdown during which the old mill and its foundations were replaced by the new installation. An interesting feature of this program was the use of a prefabricated "bird cage," made up of all the ducts, bolts, reinforcing steel and forms for the main foundation. Also, of interest was the relocation of the new mill from its off-site assembly area onto the new foundations. Although the construction program was set up primarily to reduce the length of shutdown required, it is interesting to note that a number of other advantages appeared. The off-site assembly of the mill permitted operating and maintenance personnel to become familiar with the new equipment; also the actual assembly was more painstaking than is usually possible, as time was not a primary factor. The use of the new electrical equipment to drive the old mill resulted in a step-by-step checkout under operational conditions which eliminated the normal startup troubles. Previous to the hot mill shutdown, a sufficient inventory of hot strip coils had been accumulated for 30 days of cold mill production. This inventory and the successful completion of the 15-day installation program, ensured against any interruption in the scheduling of cold rolled products.

ROLLING MILL DEVELOPMENT PRIOR TO 1940

Hot rolling mill operations at Dominion Foundries and Steel Ltd. started with the installation of a 2-high universal plate mill in 1918. The mill, as originally installed, had 27 x 72-in. work rolls and 21 x 36-in. attached edgers on both sides. The mill and edgers were driven through a special pinion stand by a single 2250-hp motor. The mill produced plate which was rolled direct on the single mill.

In 1933, the mill was altered to take 30 x 84-in. horizontal work rolls and 22 x 36-in. vertical rolls.

In 1934, a cold mill installation necessitated the pro-

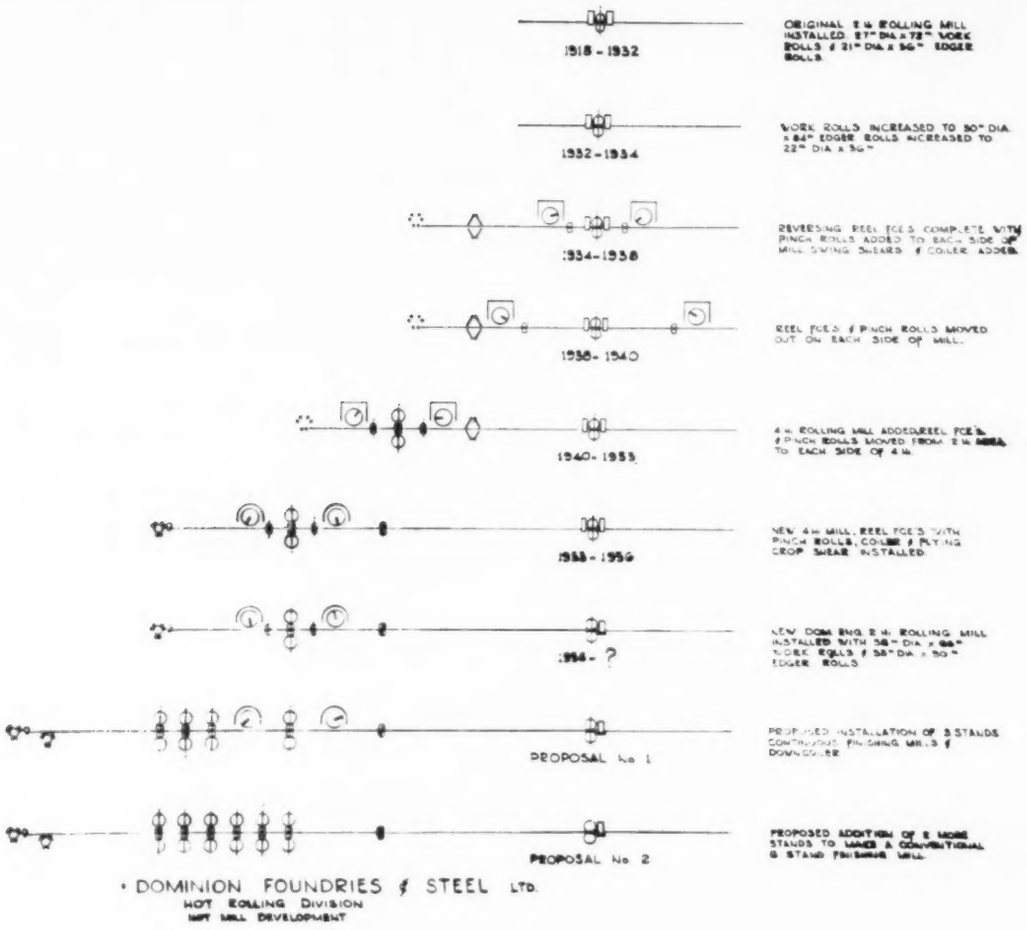

1918 - 1932
ORIGINAL 2 H. ROLLING MILL INSTALLED. 27" DIA x 72" WORK ROLLS & 21" DIA x 36" EDGER ROLLS
1932 - 1934
WORK ROLLS INCREASED TO 30" DIA. x 84" EDGER ROLLS INCREASED TO 22" DIA x 36"
1934 - 1938
REVERSING REEL FCE'S COMPLETE WITH PINCH ROLLS ADDED TO EACH SIDE OF MILL SWING SHEARS & COILER ADDED
1938 - 1940
REEL FCE'S & PINCH ROLLS MOVED OUT ON EACH SIDE OF MILL.
1940 - 1953
4 H. ROLLING MILL ADDED REEL FCE'S & PINCH ROLLS MOVED FROM 2 H. MILL TO EACH SIDE OF 4 H.
1953 - 1959
NEW 4 H. MILL, REEL FCE'S WITH PINCH ROLLS, COILER & FLYING CROP SHEAR INSTALLED.
1959 - ?
NEW DOM ENG. 2 H. ROLLING MILL INSTALLED WITH 38" DIA. x 84" WORK ROLLS & 38" DIA. x 30" EDGER ROLLS
PROPOSAL No 1
PROPOSED INSTALLATION OF 3 STANDS CONTINUOUS FINISHING MILLS & DOWNCOILER
PROPOSAL No 2
PROPOSED ADDITION OF 2 MORE STANDS TO MAKE A CONVENTIONAL 6 STAND FINISHING MILL.
• DOMINION FOUNDRIES & STEEL LTD.
HOT ROLLING DIVISION
HOT MILL DEVELOPMENT

Fig 1—Chronological expansion of the hot rolling division.

duction of hot strip. Strip reel furnaces and pinch rolls were added to the 2-high mill so that it could serve as a reversing hot strip mill. The mill runout tables were extended and a coiler and set of swing shears added. The mill rolled ingots direct into hot strip using the reel furnaces. This setup, with some variations, was used until 1940, when a 4-high reversing hot strip mill was installed, and the reel furnaces moved to that mill. With the 2-high and 4-high reversing mills, ingots were rolled to $\frac{3}{4}$-in. breakdown on the 2-high and then processed into hot strip on the 4-high without reheating—other than the reel furnaces.

As production demands increased, the original mills became more and more overloaded, with the 4-high mill being the more serious "bottleneck." In 1953, the 4-high was replaced with a modern 28 and 53 x 60-in. 4-high reversing hot strip mill complete with reel furnaces, pinch rolls and side guides. The swing shears were replaced by a rotary drum type shear, and new runout tables and a mandrel type coiler were added.

This improvement moved the production bottleneck back to the 2-high. The old mill was very limited in the range of sizes it could handle. The maximum opening was 19 in. high x 50 in. wide. Maximum side work was about 1 in. so that a very large family of ingot widths was required to give all widths of product from 20 to 48 in. The 19-in. max opening limited the mill to 15,000-lb ingots. The new 4-high mill and coiler were built for 30,000-lb ingots. As production expanded, the old 2-high with its 2250-hp motor, became more and more overloaded. Maintenance became an art, and the possibilities of a major breakdown increased. Such a breakdown would have seriously affected the company as all hot mill and cold mill product passed through the 2-high, and any extended shutdown of the 2-high could have caused a shutdown of all rolling operations.

In late 1955, it was decided to replace the 2-high hot rolling mill along with its approach and runout tables with a modern installation. The various stages of the hot mill development are illustrated in Figure 1.

FIRST CONSIDERATIONS

Once it was decided to replace the mill, the question arose, "With what?" Step by step, the details emerged of a mill which would best suit our operations. A 2-high universal slabbing mill was obviously required to roll direct from ingots to heavy plate or to $\frac{7}{8}$-in. breakdowns for skelp and hot strip reduction on the 4-high reversing hot mill.

Mill production in the order of 100,000 tons per month was required compared to the old maximum of 55,000 tons per month. The mill was to handle much bigger, heavier ingots, up to 29 in. thick and 30,000-lb max weight. Side reductions of 4 to 8 in. were required so that ingot mold inventory could be reduced. The use of a separate edger was considered, but space limitations, quality of strip edge and layout all pointed to a close coupled edger. Mill drives were figured in the conventional manner—based on the production and ingot widths stated. It was decided that the mill would have 54-in. lift so that ingots could be rolled on edge. A manipulator was not considered necessary with the proposed level of production. Instead, a setup to deliver ingots on

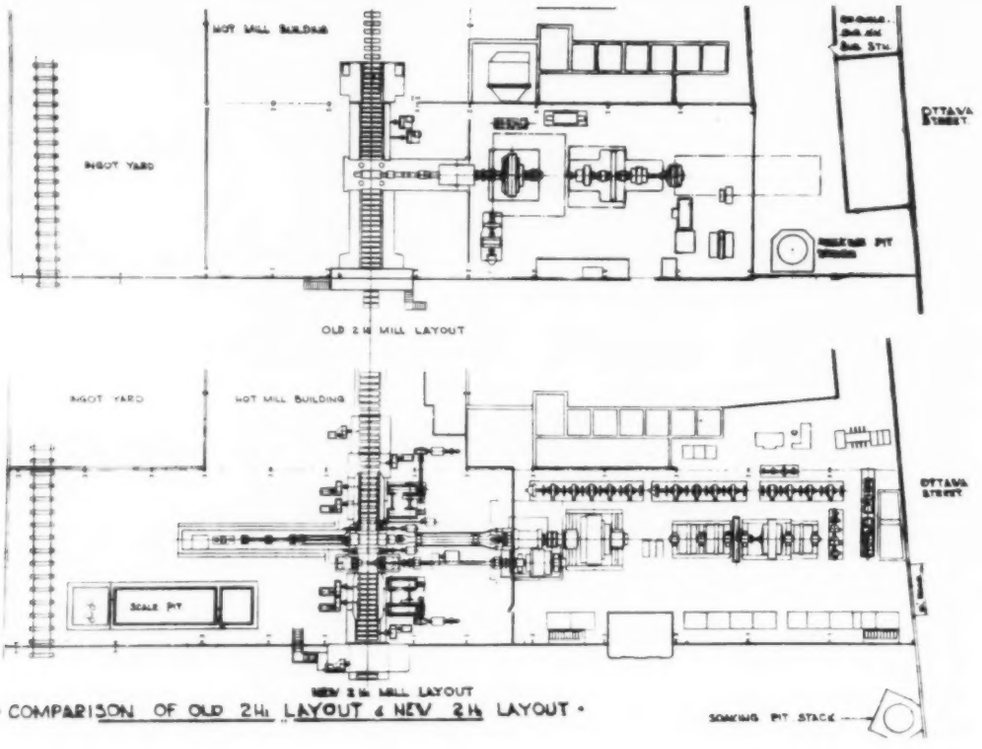
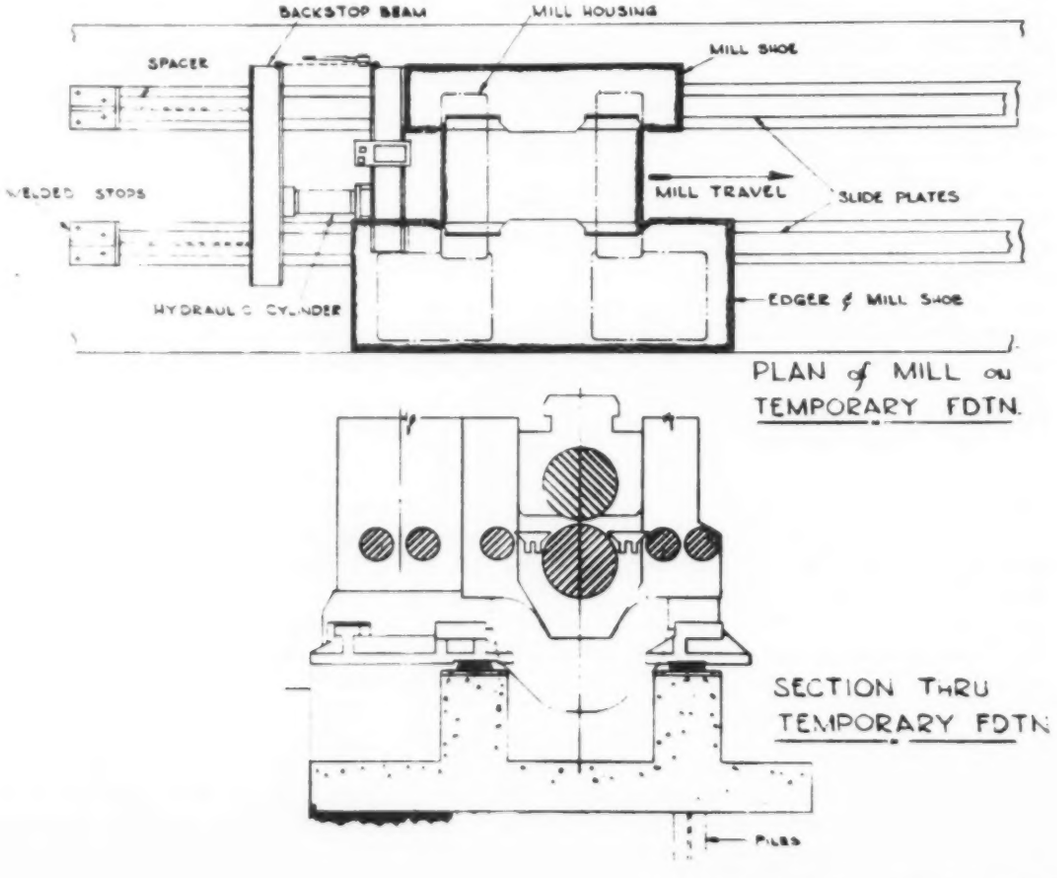


Figure 2 — Comparison of the old and new 2-high layouts.

edge to the mill was to be installed, with a "downender" at the mill, so that side reduction with the ingot on edge could be done on the early passes. All of these factors pointed to a mill and attached edger similar to the mills at Kaiser Steel, Fontana, Cal., and Lone Star Steel in Texas. It was decided to go ahead with a 38 x 66-in. mill of this type with 5000 hp on the main rolls and 2000 hp on the edger rolls. Mill speed to match the present setup was 796 fpm max.

The next question was location of the new mill. Placing the new mill between the old 2-high and the 4-high would have reduced the maximum ingot size by restricting runout table length and would have required a complete new building to give the headroom required.

Figure 3 — Prior to mill changeover, the new mill housings were assembled on two rails for easy movement into their final positions.



No area ahead of the 2-high could be used as this would be in the soaking pit building. These considerations made it apparent that the new mill must go on the same site as the old 2-high mill.

The old 2-high mill was located in a building at right angles to the main plate mill building. It had no access to either roadway or railroad tracks. However, it was seen that a short extension on each end of the cross building would give access to a city street at the motor room end, and to a plant track at the mill end. The building extensions would also provide space for construction work on the mill, Figure 2.

When it was decided to locate the new 2-high mill on the old mill site and do the job in a minimum of time, it became obvious that some new method of installation must be used. The length of time required to remove the old mill and completely install the new mill was estimated at 40 days. A shutdown of this length was out of the question so ways and means of making a fast changeover were sought.

It was first suggested that the new mill could be built on the old foundation altered as little as possible. Investigation showed that this was not practical as the old foundations were in bad shape and too small for the new mill. It became obvious that the more work done ahead of the actual mill changeover, the shorter would be the time involved. With this in mind, it was decided to replace and extend the mill approach and runout tables ahead of the mill change. The changeover would be made in short sections which could be completed in the normal weekly maintenance period of eight hours. The mill electrical equipment and drives could be changed over progressively using the maintenance period for any downtime required. The new main motor-generator set would be installed behind the old unit, tested out, and then put into service driving the old mill motor. The old motor-generator set could then be removed, and its site used for installation of the new mill motor behind the old mill motor. This process was to be carried on so that when the mill changeover took place, the old mill and pinion stand would be all that remained of the original installation and the new tables, mill electrics and drives, would be complete and operating, Figure 2.

After detailed planning of the work involved, it was decided to go ahead with the progressive changes as described and limit the mill changeover shutdown to about 15 days. This presented a large problem as the building of a new mill foundation would normally take 10 to 12 days, and the assembly of the mill would require a further 25 days.

Acting on a suggestion from the chairman of the board, F. A. Sherman, it was proposed that the new mill be built in front of the old mill so that it would be almost completely erected when the shutdown began. We could then remove the old mill and foundations, install the new foundations, and move the complete new mill, weighing 450 tons onto the new foundations, thus saving the mill erection time.

The new housings rest on two large "shoes," and it was proposed that these shoes be machined on the underside to suit two 16 in. wide x 4½ in. thick steel "rails" which would run from the mill erection site to the final location. The rails were to be laid first at the erection site, then extended as the old mill was removed,

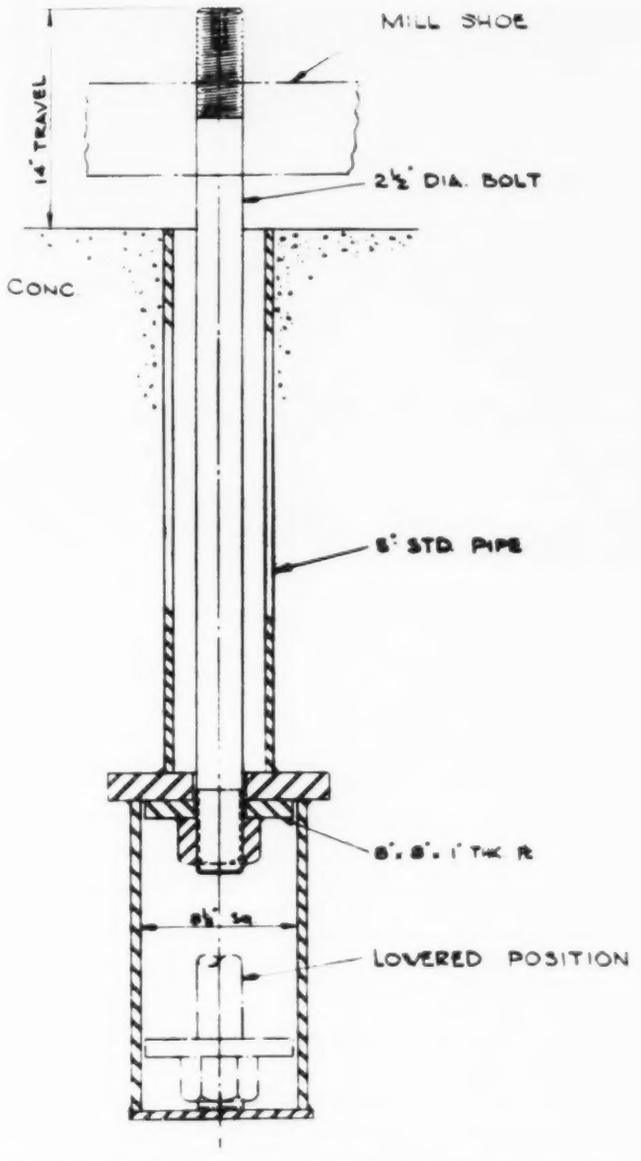


Figure 4 — One feature of the "bird cage" was the "vanishing" bolts for the mill shoes.

and the new foundations installed. The mill was then to be completely assembled off-site and pushed along the rails to the final location, Figure 3. Investigation of this proposal showed only one objection, no one had done it before.

The fast installation of the mill foundations was next considered. To save time on forming, reinforcing, setting of bolts, conduits, ducts, etc., it was decided to build all the foundation hardware into a prefabricated "bird cage," Figure 4, which could be set and leveled in the excavation and then have concrete poured around it as in normal construction. One feature of the bird cage was the "vanishing" bolts for the mill shoes. These were captive in a sway tube, with enough lengthwise movement that they could be 12 in. above the concrete or one in. below. The use of a square head in a square tube prevented rotation of the bolt. The bird cage was used to cut the foundation forming and preparation time from a normal 8 days to only 12 hours.

After these decisions were made, careful scheduling and planning indicated that a shutdown of 15 days would be sufficient for the mill changeover. It was

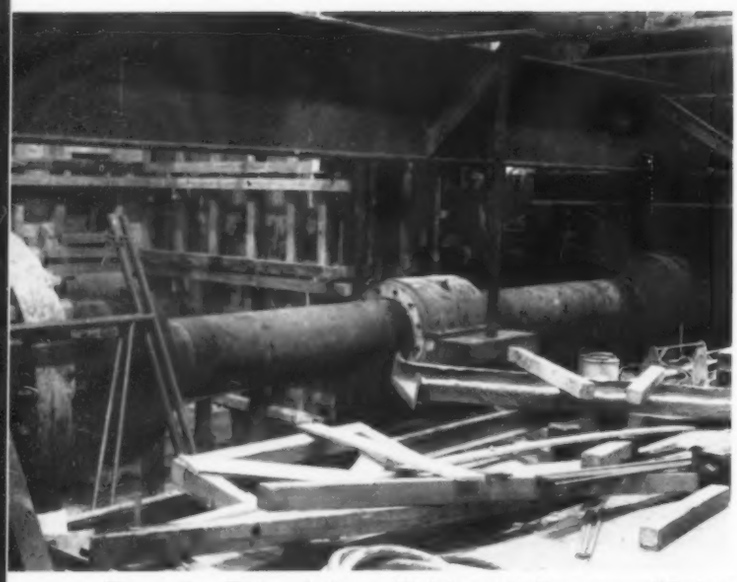


Figure 5 — This existing mill drive spindle was modified to connect the new mill motor to the old pinion stand.

decided to go ahead on this basis with the shutdown scheduled for early 1957, by which time a sufficient inventory of hot strip coils would be on hand to keep the cold mills operating during the hot mill shutdown period.

STAGES OF PRELIMINARY CONSTRUCTION PRIOR TO MILL SHUTDOWN

The first job was to clear the site. In the motor room building extension area, an air handling system for the old mill motor room and a soaking pit stack were in the way of the new work. The air handling system was easily relocated so that it could be used as required and still clear the construction work to come. The removal of a soaking pit stack was more difficult. A complete new foundation, stack and part duct were erected in an adjoining building. Then, in May, 1956, during a 16-hour shutdown, an elbow in the original duct was replaced with a connection to the new stack duct. The old stack was then removed. Work on the motor room building extension was then started, along with underpinning the columns of the existing motor room so that the heavy new equipment could be handled by overhead crane.

Figure 6 — Working under the mill drive spindle, the construction crews built the pinion stand and edger motor foundation.

The main motor-generator set foundation and part of the ventilating basement were constructed along with the building extension. When the extension was complete, a temporary partition was erected at the end of the old motor-generator set to separate the operating equipment from the construction site, and to keep dust away. The installation of a new 75-ton crane in the motor room extension made work much easier.

The new main motor-generator set and auxiliaries were installed, tested and put into operation. On January 31, 1957, during a 16-hour shutdown, the old motor-generator set was taken off the line, and the old mill motor connected to one of the three 2000-hp generators on the new motor-generator set. After a trial period of 12-hr operation with this arrangement, approval was given to remove the old motor-generator set and proceed with the next stage of the changeover.

The old motor-generator set and its foundation were removed after the new motor-generator set, old mill motor and auxiliaries were encased in ventilated wood and sheet metal "houses." This housing of operating equipment prevented damage by dust and construction equipment.

The new mill motor foundation was constructed on the old motor-generator set location, and erection of the motor and its auxiliaries was completed and the motor test run on March 20. While this work was going on, an existing 24-ft long mill drive spindle was modified, one end to suit the half coupling on the new mill motor, the other end to connect to the existing pinion stand. A spindle carrier was built to suit the setup and, during a scheduled 16-hour maintenance shutdown on March 26, the old mill motor was lifted off the bedplate and the 24-ft spindle installed to couple the new mill motor to the old pinion stand, Figure 5. After a 12-hour test run, approval was given to go ahead with removal of the old motor foundation.

The new pinion stand and edger motor foundation was built on the site of the old mill motor, working under and around the 24-ft connecting spindle, Figure 6. The concrete work was completed on April 12, and the edger motor was moved into place.

Work on the motor room auxiliary equipment was carried on at the same time as the main steps. The 60-cycle substation, auxiliary motor-generator sets, and the ventilating and lubricating equipment were installed as the work went ahead so that a finished motor room was ready for the final shutdown.

While the new motor room was under construction, work was started to change over the mill runout tables. The new table drives were located so that they did not interfere with the old table drives. They were installed and tested before any table changes were made.

On October 30, 1956, the maintenance shutdown was increased to 16 hours and a 16-roll section of the new mill runout table, Figure 7, was successfully installed. The existing foundations were used with adapters to suit the old bolts—the location of which was best described as random.

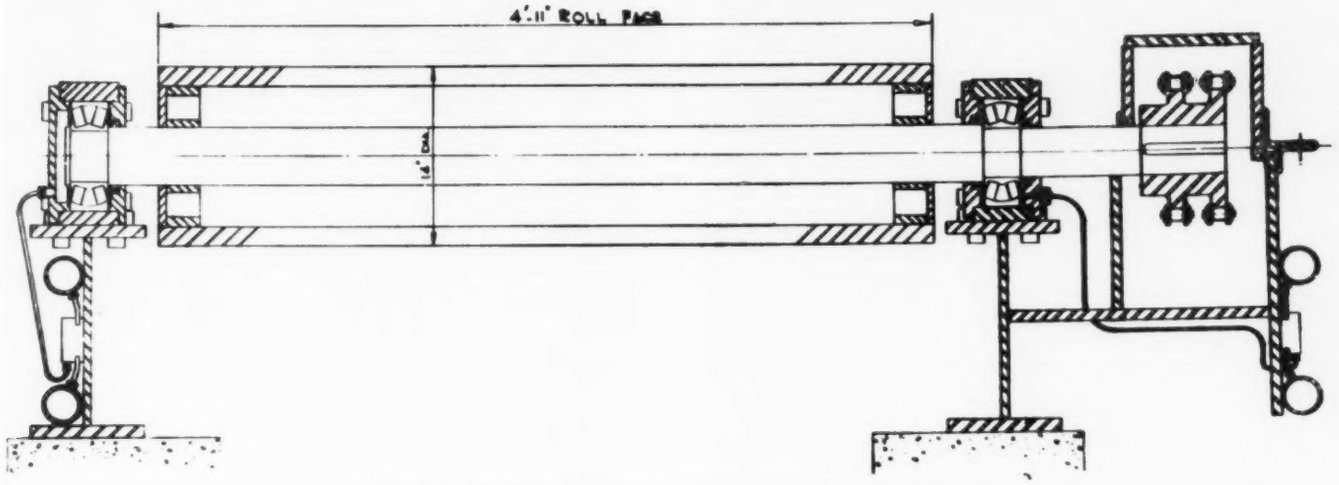


Figure 7 — Section through a 16-roll runout table section.

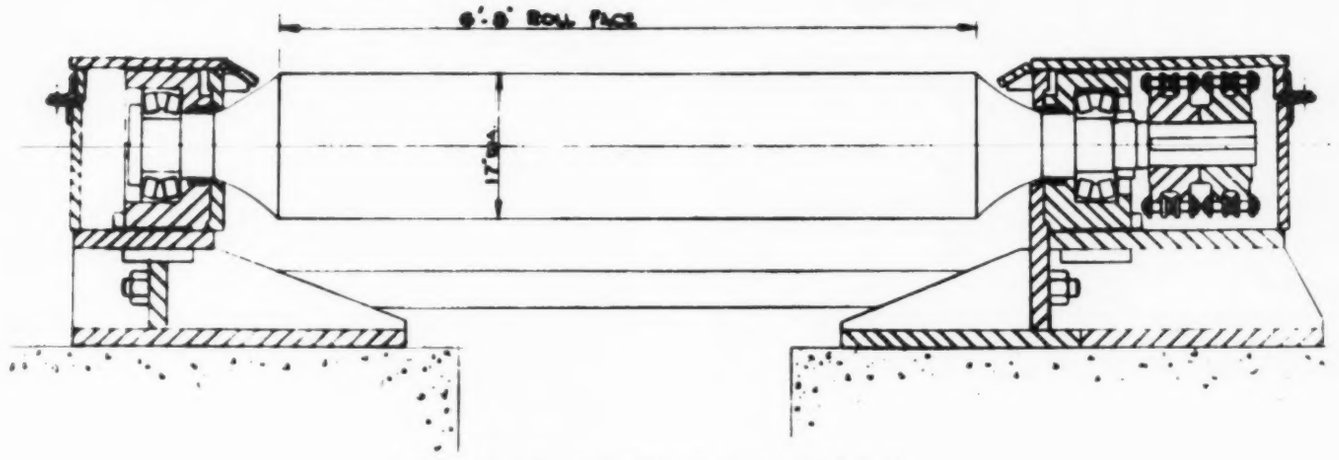


Figure 8 — Section through an approach table.

The new chain-driven tables have 14-in. diam x 60-in. long face rolls fitted with antifriction bearings. The drives are one 610 mill motor and gear reducer per 16 rolls. The tables were designed by our company and fabricated in various Canadian plants, from our plate and castings. The changeover continued in similar stages until the new runout table was completed.

An extension to the mill approach tables was built without reference to mill operations as this work did not interfere with any existing equipment. These tables are similar to the new runout tables.

The changeover of the mill approach tables was handled the same way as the runout table change. The job was done in two sections each requiring a 24-hour shutdown which was also used for regular maintenance work. The replacement tables, Figure 8, have 17-in. diam x 80 in. long, forged steel rolls, fitted with antifriction bearings. Table drives are one 610 motor and gear reducer per six rolls. The rolls are chain driven, and both the free end bearings and the drive end bearings and chains are encased in a continuous closed trough. An interesting feature is that the approach tables are identical with the new mill tables in all mechanical details. The mill table drives are heavier to suit the higher duty cycle.

The new approach tables were completed in March, 1957. The mill end building extension was planned to include underpinning of existing building foundations, and the construction of a new scale pit and the mill erection foundation. This work was carried out without interrupting mill operations; anything which required mill downtime was done during the regular maintenance and roll change periods.

The new scale pit is 50 x 10 ft including the inflow chamber, settling chamber and pump chamber. It is set up as a water recirculating system which continuously flushes scale from under the approach tables, mill and mill tables into the scale pit. Make-up water comes from roll cooling and descaling sprays. The pit is finished flush with the floor and is fitted with 4-in. thick steel slab covers so that a clear floor is provided.

When the mill erection foundation was completed, the first 70 ft of slide rails were installed, leveled and grouted. The rails were set to an elevation so that the mill would be erected with the pass line at the correct level. No allowance was made for compression of the foundations. The foundation and slide setup is illustrated in Figure 3.

After the rails were correctly positioned, they were polished in the direction of mill travel and a layer of molybdenum disulphide grease applied. Erection of the mill started in January, 1957, and was complete by April except for rolls and spindles. The main screws were "run-in" using the d-c shop bus and a circulating lubrication system. When this stage was reached, the hydraulic jacking setup for moving the mill was tried

Figure 9 — A temporary pulpit for the old mill was erected on one side of the mill tables, and the old pulpit was removed so that the new pulpit could be erected in its location.

out, and the mill was twice moved a distance of 6 ft with a maximum push of 40 tons. The jacking arrangement is shown on Figure 3.

To reduce the amount of work on the 15-day shutdown, every effort was made to complete all possible parts of the program ahead of the shutdown. During the last weeks before the changeover, a 16-hour weekly maintenance shutdown was scheduled instead of the regular eight hours. This was used for changeover of some piece of equipment which would otherwise be changed on the shutdown. A temporary operating pulpit for the old mill Figure 9, was erected to one side of the mill tables, and the old pulpit was removed. Installation and wiring of the new pulpit in the old pulpit location then went ahead. Two sections of the new mill tables were installed, and the drives of the remaining tables were installed and test run.

The mill side guides and mill tables were built into major sub-assemblies and located near the mill site. The mill foundation "bird cage" was built and loaded on two flat cars so that it could be moved to the site with no delay. Steel forms for the mill table and side guide foundations and for the roll change rig foundation were built and stored near the site.

When the shutdown date arrived, very little remained of the old installation other than the mill, and all parts of the new installation were on site ready to move into place. Excavation for the new mill foundation was completed right up to the old mill from all sides so that a minimum of concrete remained to be removed at shutdown, Figure 10.

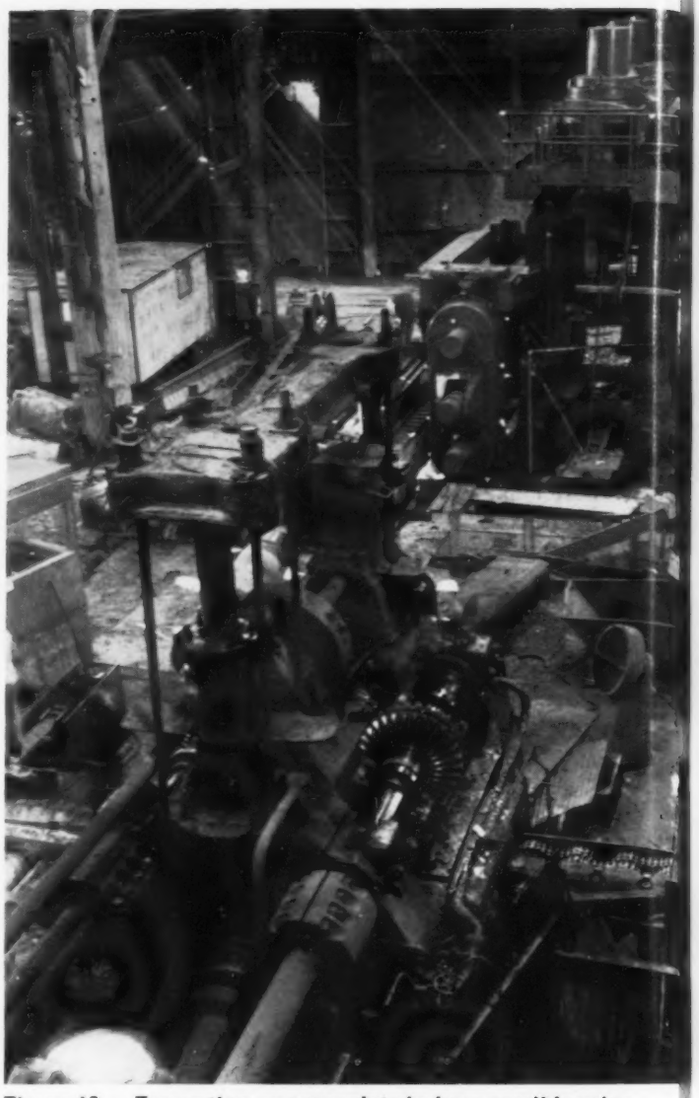


Figure 10 — Excavation was completed where possible prior to mill shutdown.

MILL CHANGEOVER

The 15-day shutdown began on May 5, at 2:30 PM when the last ingot was rolled on the old 2-high Figure 11. The schedule called for operations to resume at 8:00 AM on May 21—the first ingot actually was rolled on May 20 at 8:00 PM.

When the shutdown began, plant personnel worked along with the contractors personnel to remove the old 2-high, with its pinion stand, the remaining mill tables, and mill side guides. The old mill, mill tables and side guides were taken out of the mill end of the building in railroad cars, and the pinion stand out the motor room end where it was loaded on to a float in the motor room. When the old pinion stand moved out, the new pinion stand base was ready on a float and was moved into place. Assembly and alining of the pinion stand went ahead while the mill foundations were under construction. Removal of the old mill and table foundations started immediately at shutdown and the drilling of dynamite holes went on as fast as the old equipment could be removed, Figure 12. A total of 500 cu yd of concrete was removed using dynamite, air breakers and a 2-yd backhoe. The old concrete contained no reinforcement. In some places it was hard and in excellent condition; in many places it was oil soaked and shattered.

Dynamite was not too effective in this excavation—due to the closeness of the mill equipment, charges had to be kept small and the already broken concrete heaved and fell back in place instead of shattering. The old foundation bolts were well rusted in and made very difficult digging for the backhoe.

The first major concrete pour was made on Wednesday, May 8. After three days of excavation the floor area on the drive side of the mill was "formed up" while digging continued on the mill and operating side foundations. The pour was about 250 cu yd and brought the "progressive" foundation right to the back of the area which would contain the prefabricated "bird cage," Figure 13. The entry guide foundations were also poured at this time.

Excavation for the main mill foundation was completed down to the pile caps of the old foundation on Thursday. These piles were 28 to 30-ft long timbers driven in blue clay down to bed rock in 1920. They were checked by drilling and were found to be still sound and dry. Ten additional 10-in. wide flange steel piles were driven to widen and reinforce the foundation. These piles were driven by a rig suspended from the overhead crane while digging was still in progress. Piling and digging finished together and a 12-in. reinforced concrete mat was poured to be a base for the "bird cage." Twelve hours after the mat pour, the bird cage, total weight 30 tons, 20 x 37 x 10 ft high, was dropped into place in two pieces, positioned and anchored ready for the 350-cu yd main pour which was made on Friday, Figure 14. 3500-psi early strength concrete was specified for this pour and a very careful check was made on all batches used. Inspectors were stationed both at the site and at the batching plant. Slump tests were made on every truck load, and a large number of test cylinders were taken so that setting time could be checked.

While the foundations were under construction, work went ahead on wiring and installation of the new pulpit, the remaining electrical equipment, the south side guides, installation and piping, accumulators and pumps for the roll balance, spindle balance, edger pullback and descaling equipment.

As soon as the main foundations had taken an initial set, the remainder of the mill slides were dropped into place, leveled and grouted with quicksetting cement, Figure 15. These slides were an extension of those on which the mill was erected and consisted of two steel slabs, 16 x 4½ in. in 10-ft long sections. The complete slides were about 95 ft long. Each slide matched a groove in one of the mill shoes. Slides were machined before installation and then polished in the direction of the slide after installation.

The main foundation concrete was checked every hour after 24 hr, using the test cylinders taken during the pour. The strength reached 2400 psi on Sunday morning, and it was decided to start moving the mill into place. Grease was pumped through the fittings on the mill shoes which lubricated the slides, and molybdenum disulphide grease was spread on the exposed part of the slides. The jacking setup consisted of a 2-section telescopic type jack, 14 and 10-in. diam rams with 12-in. stroke on each. The jack was fed from an air-operated, low capacity, high-pressure oil pump. Both the pump and the jack traveled with the mill. The jack was backstopped on a beam which rested against stops welded on the projecting ends of the mill slides. The mill moved along in 24-in. steps, and the beam was then pulled up to the mill by two 2-ton "comalongs," collapsing the jack in the process. Spacers in 2-ft steps were added between the beam and

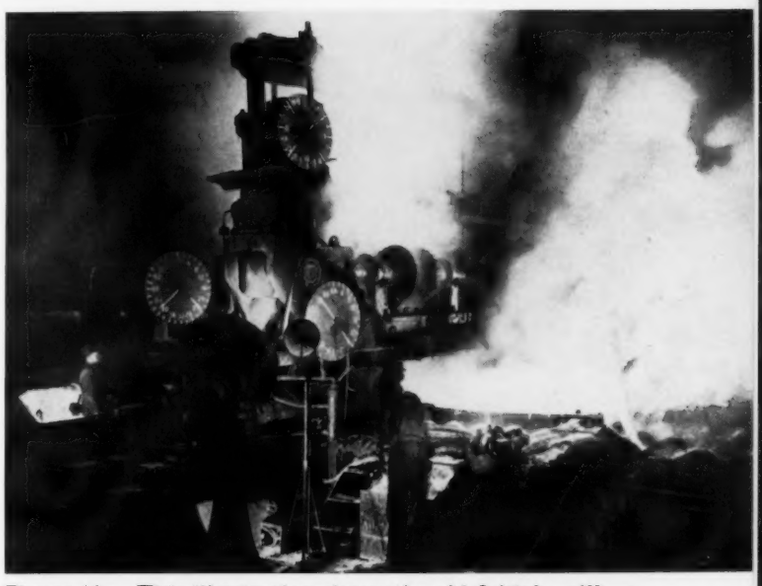
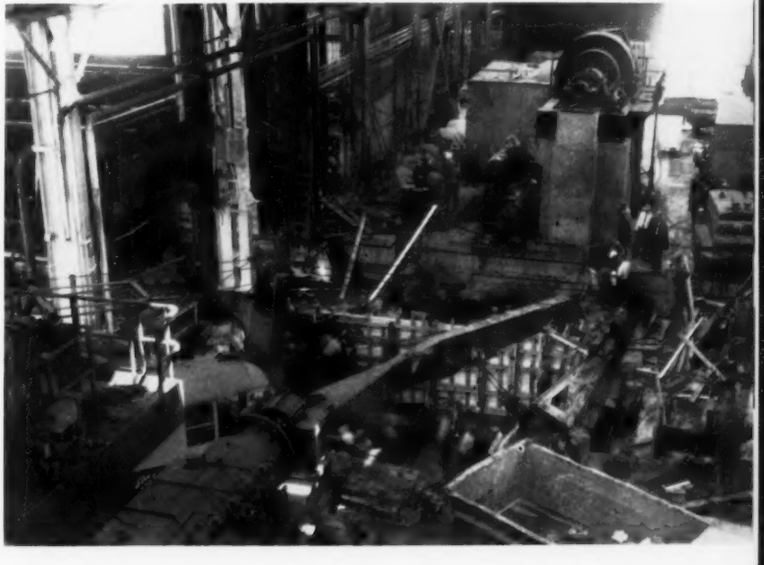


Figure 11 — This illustration shows the old 2-high mill as the last ingot was rolled on it.

Figure 12 — Removal of the old mill and table foundations started immediately at shutdown.

Figure 13 — The first concrete pour, 250 cu yd, brought the foundation to the back of the area which would contain the prefabricated "bird cage."



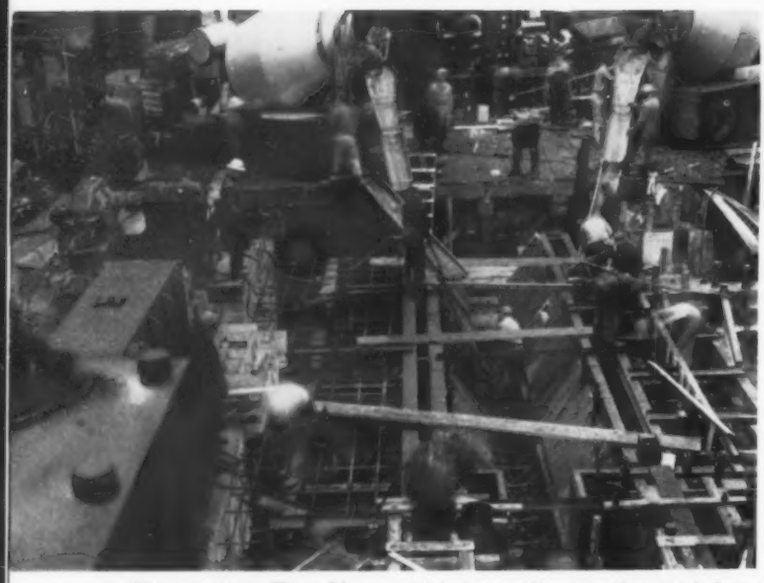
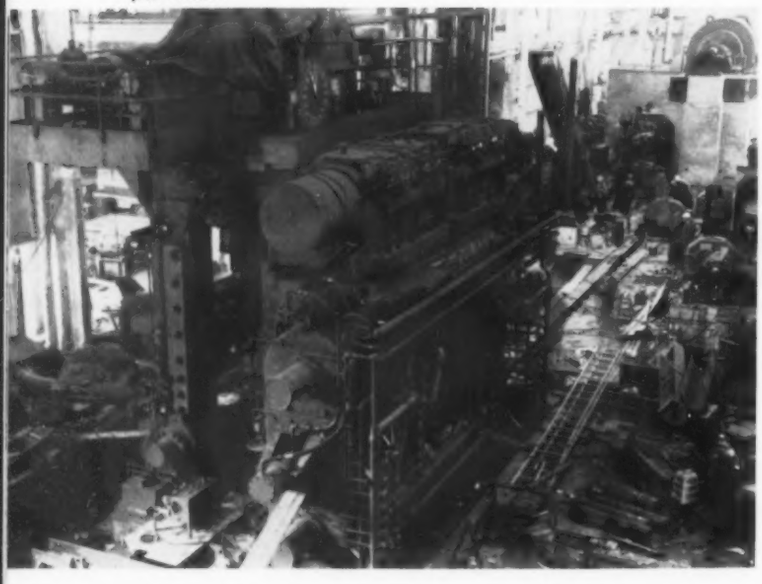


Figure 14 — The 30-ton "bird cage" was dropped into place in two sections.

Figure 15 — When the main mill foundation had taken an initial set, the remainder of the mill slides were dropped into place.

Figure 16 — The mill is being slid along the rails into position.



the stops until the spacers were 10 ft long. Then new stops were welded on to the slides and the move began again, Figure 16. The total distance moved was 72 ft, at the rate of ½ in. per minute. The pushing force averaged 40 tons to move a dead weight of 450 tons.

When the mill was close to its final position, a wire was run between the housing posts along the mill tables on frames which had been set up ahead of time. The mill was "spotted" by alining plumb bobs hung from this wire with pop marks which the erectors had made on the center-line of the mill. The mill was then checked to the final lines and was found to be right in position, but rotated slightly on its center, in the amount of 0.015 in. in 12 ft. This was corrected by blocking the mill at one corner and jacking against the diagonal corner to rotate the mill about its axes. When it was within 0.003 in. in 12 ft, the mill shoes were welded to the slides. The "vanishing bolts" were drawn up through the shoes, and fitted with nuts and washers to complete the setting of the mill. The mill was given a final check for alinement in the horizontal and vertical planes, and it was found to be exactly the same as the original setup in the assembly shop. While the work on the mill was in progress, the old table foundations were broken down and replaced by new foundations which were poured inside permanent forms made of 1-in. steel plates. The mill screwdown platform stairway was put into its final position before the mill move and held by a temporary support so that the hydraulic and lubricating piping and electrical ducts could be run up to meet the lines which were already installed on the mill. The mill tables were installed, all except the inner sections which would have interfered with the mill while it was moved into place. The mill side guides were being installed as work on the tables progressed.

As soon as the mill had moved, the assembly area was filled and formed up for the roll change pit, and this was poured on Tuesday, May 4, so that installation of the roll change rig could start on Wednesday, Figure 17. Work on the mill continued as soon as it was in place. The main and edger spindles and spindle carriers were installed. The feed roll and edger screw-in drives were installed; and the piping and wiring finished; mill tables and side guides were completed and tested out. By Friday mechanical assembly of the mill was complete except for final alinement of the side guides and installation of the work rolls. Our millwrights at this point took over from the contractors millwrights so that they could become familiar with the mill by installing the rolls and setting the guides.

The floor in front of the mill was finished on Friday, and the final electrical and mechanical checkout commenced Saturday. This work went on through Sunday and Monday, Figure 18.

On Monday, May 20, the mill was complete, rolls installed and ready to run, and at 8:00 PM the first ingot was rolled in the mill—15 days and 6 hours ingot-to-ingot, Figure 19.

Some work was still to be done; the partition between the mill and motor room had to be installed and clean-up of the construction debris, painting and general finishing off was required. All work was completed two weeks after the first ingot was rolled on the new mill.

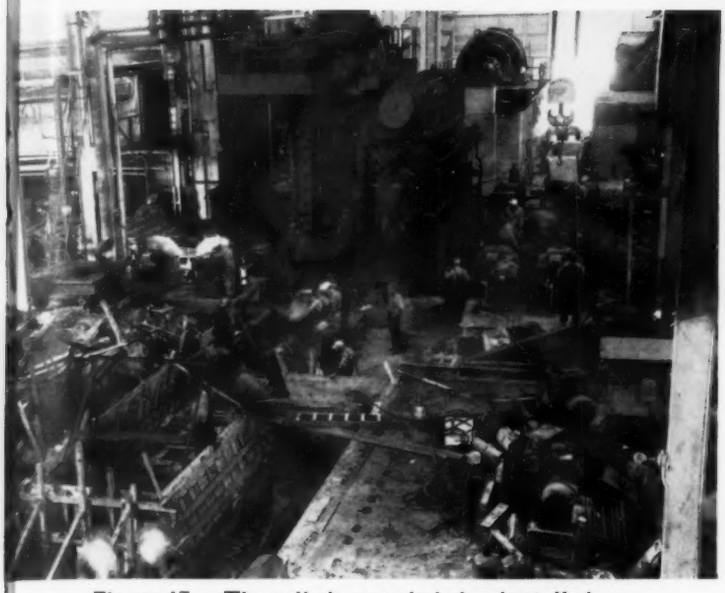


Figure 17 — The roll change rig being installed.

Figure 18 — The final mechanical and electrical checkout work took two days.

The equipment to deliver ingots to the mill on edge was installed after the mill was operating, on foundations which had been prepared during the last days of the mill shutdown.

The equipment to "downend" the ingots at the mill, was incorporated on one of the entry side guides. It was in effect a hydraulic manipulator with a 15-in. lift.

Discussion

PRESENTED BY

HARRY JONES,
Product Engineer, Industrial Div.,
Dominion Engineering Works,
Lachine, Quebec, Canada

DAVID HUGH SAMSON,
Project Engineer,
Dominion Foundries & Steel Ltd.,
Hamilton, Ontario, Canada

J. I. GREENBERGER, Group Engineer,
United Engineering and Foundry Co.,
Pittsburgh, Pa.

G. CALDER LITTLE,
Assistant Superintendent,
Mechanical Dept., Bethlehem Steel Co.,
Sparrows Point, Md.

G. L. LAMBERT, Chief Engineer,
Connors Works, Connors Steel Div.,
H. K. Porter Co. Inc. (Delaware),
Birmingham, Ala.

Harry Jones: I noticed the next proposal is the addition of three finishing stands to the reversing hot strip mill. There are other ways of installing the mills, particularly where there is now an existing runout table. One method would be to bridge the runout tables, dig out for the forms, pour the foundation, mount the bedplates, put up the housings and run the strip through the housings while the rest of the mill is put together. I would like to ask you in the light of your experience whether you would follow that method or the method you have just discussed?

David Hugh Samson: The answer to the question is that we would consider assembly off-site followed by pushing them into place. We find we can get a better assembly job off-site because there is no rush and no danger, whereas if we assemble the mill with hot steel

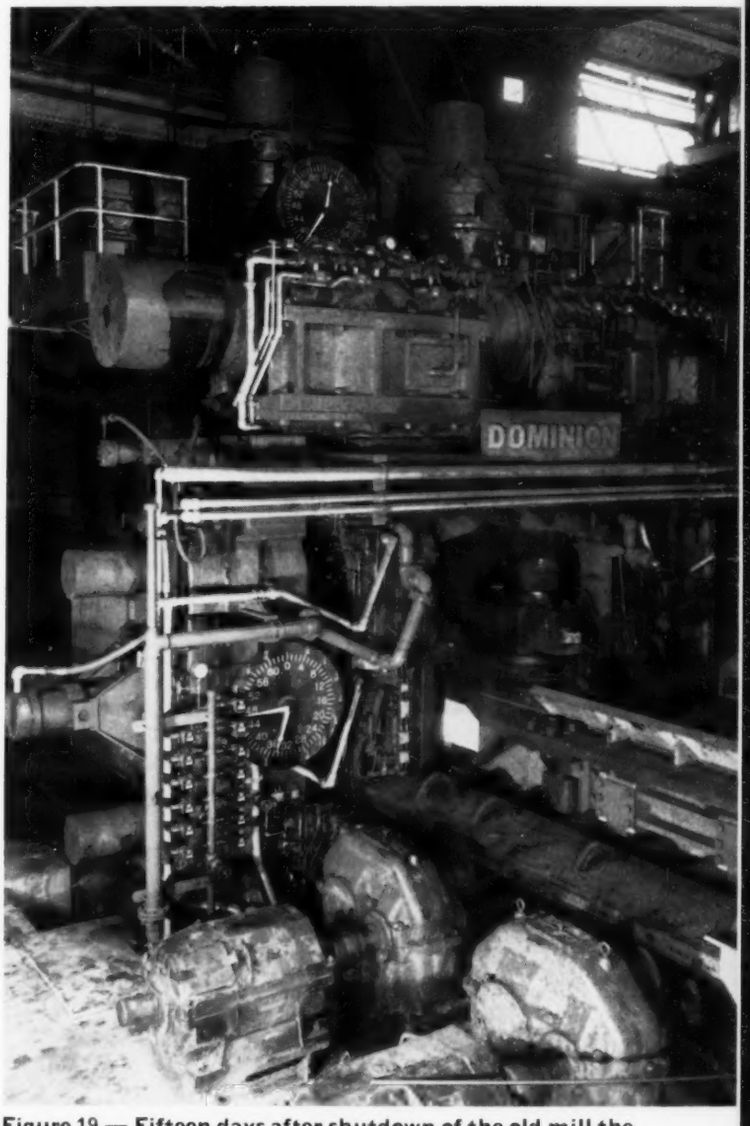


Figure 19 — Fifteen days after shutdown of the old mill the new one was rolling.

passing through it to maintain production I think it would be difficult.

J. I. Greenberger: This paper presents a lot of subject matter for all operating companies considering future modernization programs. Use of off-site erection, the breaking-in of equipment, and certain other advantages in addition to saving of time pointed out by the author should certainly merit consideration.

Any modernization program which involves putting in new equipment to operate in conjunction with existing equipment must investigate many details. It is evident from the very fine set of illustrations accompanying this paper that a vast background of planning must have gone into each step of the operation. As pointed out by the author, this installation procedure resulted in reducing downtime from an estimated 40 days to 15 days. I would like to question what was involved in the way of money. In developing the use of this "bird cage" and the off-station erection procedure, did the author's company study the economics to the point where perhaps they established what additional money was involved? In other words, how do the economics of this type of erection compare to conventional methods?

David Hugh Samson: The entire project cost $6,000,000, close enough that the change would not buy very much rolling mill. Of this money $100,000 was set aside for the scheduled overtime, and we used pretty well all of it, but the $100,000 compared to $6,000,000 is about 1½ per cent. We felt the money spent was well justified by the extra 30-days production we did not lose. We felt that this method of installation had to be back-stopped by a very good nucleus of trained men, men who knew the plant setup and knew what the operation was going to be. So, all the replacement of tables, building the "bird cage" and replacement of electrical equipment meant we could build up a core of men, a nucleus of a final large working force and get them into the way of doing things around the plant—try them out and see how they performed. By doing that, and items like building the "bird cage," which was a little more costly than the normal foundation, we kept these men occupied and obtained our money's worth from them. The "bird cage" itself, we feel, is the proper way to build a foundation. We feel that economically we did very well. The cost could be cut by eliminating overtime but on a job like that nobody works straight time and I think the conventional way would have cost about as much money in the long run.

G. Calder Little: We can well understand the problems that the author has gone through because we have had some conditions at Sparrows Point through the years of building different mills and different facilities for the plant during operation. We know something about the many problems that arise for the construction people and also for the operating people, and we feel that the author and his people should be congratulated for the excellent work they did in producing a product while the construction people were going through the routine of adding the new mill.

I have just one question that I would like to ask; this is in relation to the drive rolls for your table. I have never seen a chain drive on mill table rolls such as you have. Is this a continuous chain, or a series of short chains connecting one roll to the other throughout the length of the table?

David Hugh Samson: We use a series of short chains. Each roll has two sprockets on it at the same end, and the rolls are chained together in pairs. The drive goes into one roll which is chained to the next roll and that roll is chained to the next roll and so on. Rolls are chained together in groups of six in that manner and we have two empty sprockets on each end group so that if something happens to one of the table drives we simply add a chain and use a common drive for those two sections of table.

G. Calder Little: How is maintenance on this arrangement?

David Hugh Samson: The maintenance on the tables themselves and on the drives is fairly low. It is a design developed in our old mill, we overdesigned the tables and the chains and made up for a higher initial cost by reduced maintenance and downtime.

G. L. Lambert: Having been faced with a similar situation with the past two years (that of having to install a new mill and tables in the same site as an existing mill), it was extremely interesting to hear how others had approached the problem.

The author's comments as to the advantages gained by the necessity of careful planning apparently produced the same results for his project as they did for ours. Such programming brings out the minor details, which are too often overlooked or not definitely assigned to a particular department or craft.

We were particularly interested in the "bird cage" used to set reinforcing, hardware and ducts. It has been our experience that this phase of the work is one of the most time-consuming portions of such an installation. ▲

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ASSOCIATION OF IRON AND STEEL ENGINEERS, 1010 EMPIRE BLDG., PITTSBURGH 22, PA.

Maintenance Organization and Training

. . . . the economic consequences of breakdowns on automatic equipment make good training and organization of the maintenance function imperative . . . . without such an organization profits are lost . . . .

by C. F. McClurg,
Assistant Division Superintendent,
Maintenance and Utilities Div.,
Fairless Works,
United States Steel Corp.,
Fairless Hills, Pa.

EVOLUTION in industry is finally bringing maintenance into the realm of prestige necessary to facilitate low cost, uninterrupted production. Two of the most important problems facing maintenance management today are organization and training.

Some general aspects of maintenance and why it is becoming increasingly important will be discussed. The present day trend toward automation has reduced the number of operators per unit of production. Conversely, the demands on trained technicians and maintenance organizations are ever increasing. Maintenance is a multi-million dollar business.

In operations employing semi-continuous and continuous processes, failure of a single component can often result in great economic losses. There are many instances where these failures have resulted in complete plant shutdowns. For this reason, maintenance organizations are being given a more important role in the formation of company policies.

The drive for ever-increasing production demands machinery that is durable and easily repaired. The maintenance man must acquaint himself with equipment that is constantly undergoing change. He must study new methods and skills to keep abreast of engineering advances. The importance of the technically trained man in the maintenance department is obvious for the nucleus of many design changes originate in this department. It becomes apparent that the job done by the maintenance department is a major factor in the determination of both production and profits.

The drive is on for alert, aggressive maintenance or-

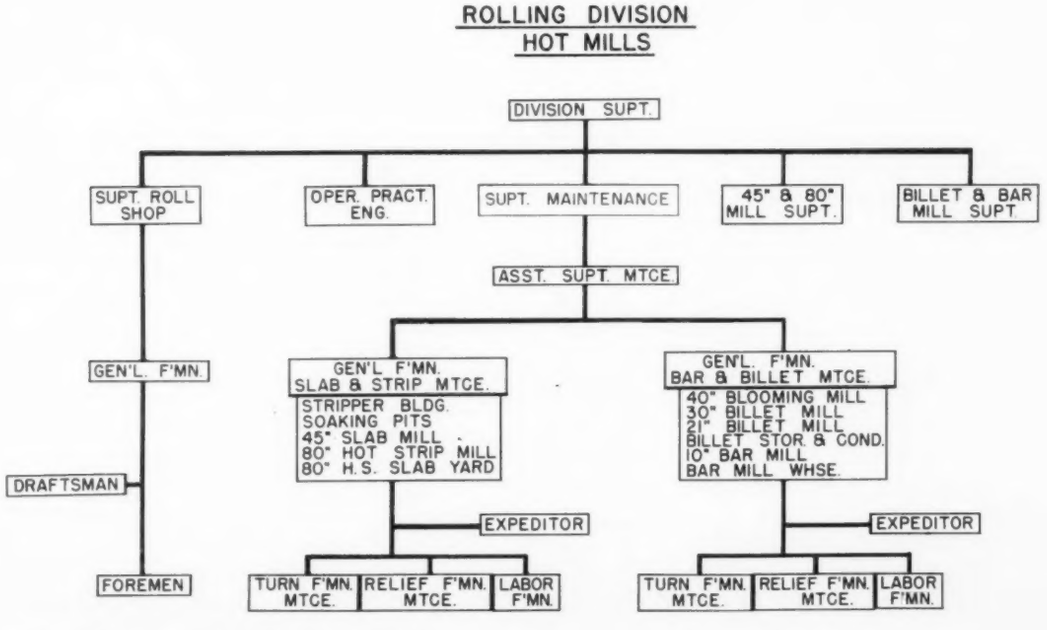


Figure 1 — This chart shows the organization of a typical area maintenance force.

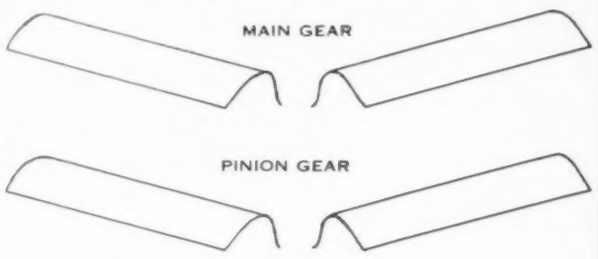
HELICAL REDUCTION GEAR INSPECTION REPORT

INSPECTED BY _____ TOTAL MANHOURS _____

DATE SCHEDULED _____ DATE INSPECTED _____

ASSEMBLY	CODE	FOUND	LEFT
CASING	RCC-CJ		
UPPER CASE	CLN-VI		
LOWER CASE	VI		
BEARING CAPS	DI-CLN		
SIGHT FLOW IND.	CLN-CF		
SPRAY NOZZLES	CLN-CF		
SUMP	CLN		
GEARS	CTC-CA		
MAIN GEAR	CLN-VI		
PINION GEAR	CLN-VI		
JOURNALS	CLN-ROD		
BEARINGS	DI-CLN		
H.S. BRG. INBD.	CLN-RB		
H.S. BRG. OUTBD.	CLN-RB		
L.S. BRG. INBD.	CLN-RB		
L.S. BRG. OUTBD.	CLN-RB		
OIL PUMP	DI		
CASING	CW-VI		
IMPELLERS	CW-VI		
SEALS	CW-VI		
OIL COOLER	DI-CLN		
WATER SIDE	FL		
OIL SIDE	FL		

TOOTH CONTACT REPORT



XXX – WIRE EDGING ●●● – PITTING

III – SCRATCHING OOO – GALLING

REMARKS

Figure 2 — Preventive maintenance records such as these are kept by area maintenance groups.

ganizations properly trained to direct their efforts at rehabilitating equipment. This is necessary to produce quality products economically. Here is a field of endeavor that has challenge, and maintenance men are rising to meet it.

Every industry has repair and maintenance problems that are peculiar to its operation. What is good from a maintenance organization standpoint for one is often unacceptable in another. Breakdown maintenance is practiced with apparent success in some locations, while preventive maintenance is the rule in others. It is, however, important that every industry, large or small, make a critical examination of their training programs and maintenance organization.

With a plant structure such as Fairless Works spread out over 3900 acres, of which 128 acres are under roof in 208 buildings, maintenance problems can be broken down into routine maintenance and specialized maintenance. Routine maintenance such as lubrication, minor repairs, inspection of equipment, and other similar tasks is handled by on-the-spot repairmen. This phase requires a working force composed of men of varied skills. These are the "jacks-of-all-trades" who have developed themselves to a high degree of proficiency. They require a general knowledge of many trades and must be prepared to handle both complex and simple adjustments. To a great degree, the success or failure of any maintenance program rests on their shoulders. Each working force services a specific area of the plant. Included in this force are motor inspectors, whose duties include cleaning, inspection and alinement of electrical equipment; mechanical problems are satisfied by millwrights who perform such tasks as bearing repair, part replacement and equipment inspection. Oilers, expediters, truck drivers, helpers and laborers round out the group.

Figure 1 indicates the size and scope of responsibility involved in a typical area maintenance force. This will vary by department, plant and by type of industry. Fairless Works has six similar area maintenance organizations. Maintenance costs appear directly as a departmental charge. The responsibility for these costs and level of maintenance is jointly shared by the operating department management and the central maintenance division. The area maintenance supervisor is the man who is actually in the "front line" of the plant maintenance program. He is directly responsible for maintenance of all equipment in his department. It is his responsibility to set up a program which includes preventive maintenance on critical equipment, periodic inspection of machinery, and provide for the ever-present threat of breakdown repairs. View graphs, card files and related records are kept on all pertinent pieces of equipment. Figure 2 is an example of the preventive maintenance records kept by the area maintenance group of the utilities department.

To successfully maintain a large plant it is also necessary to employ craftsmen in specialized trades, such as

Figure 3 — Layout of central maintenance and locomotive and mobile equipment repair shops.

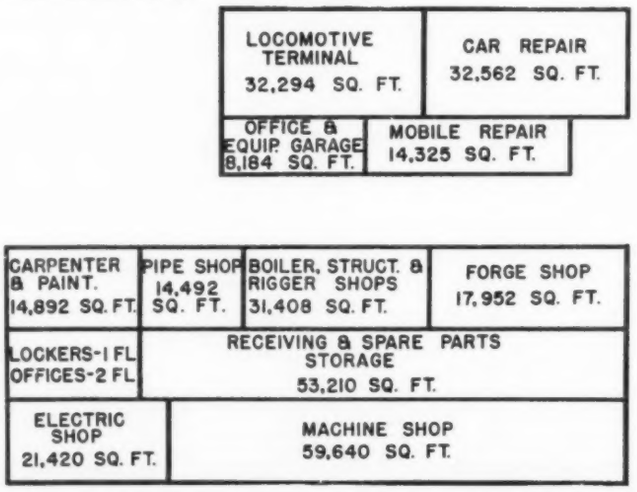


Figure 4 — The central maintenance machine shop is a modern self-sustaining shop.

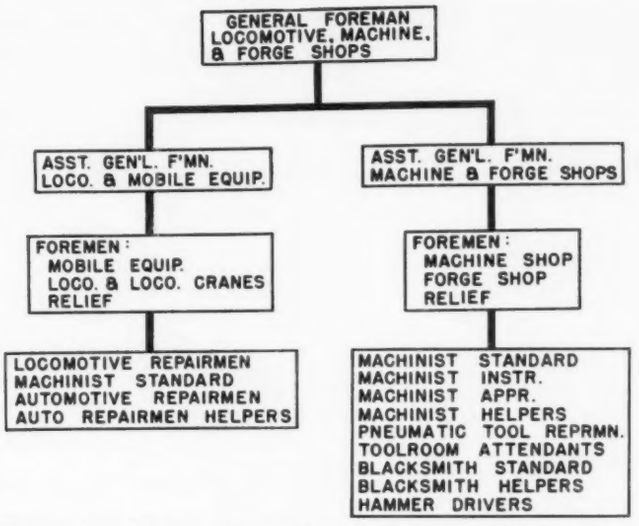
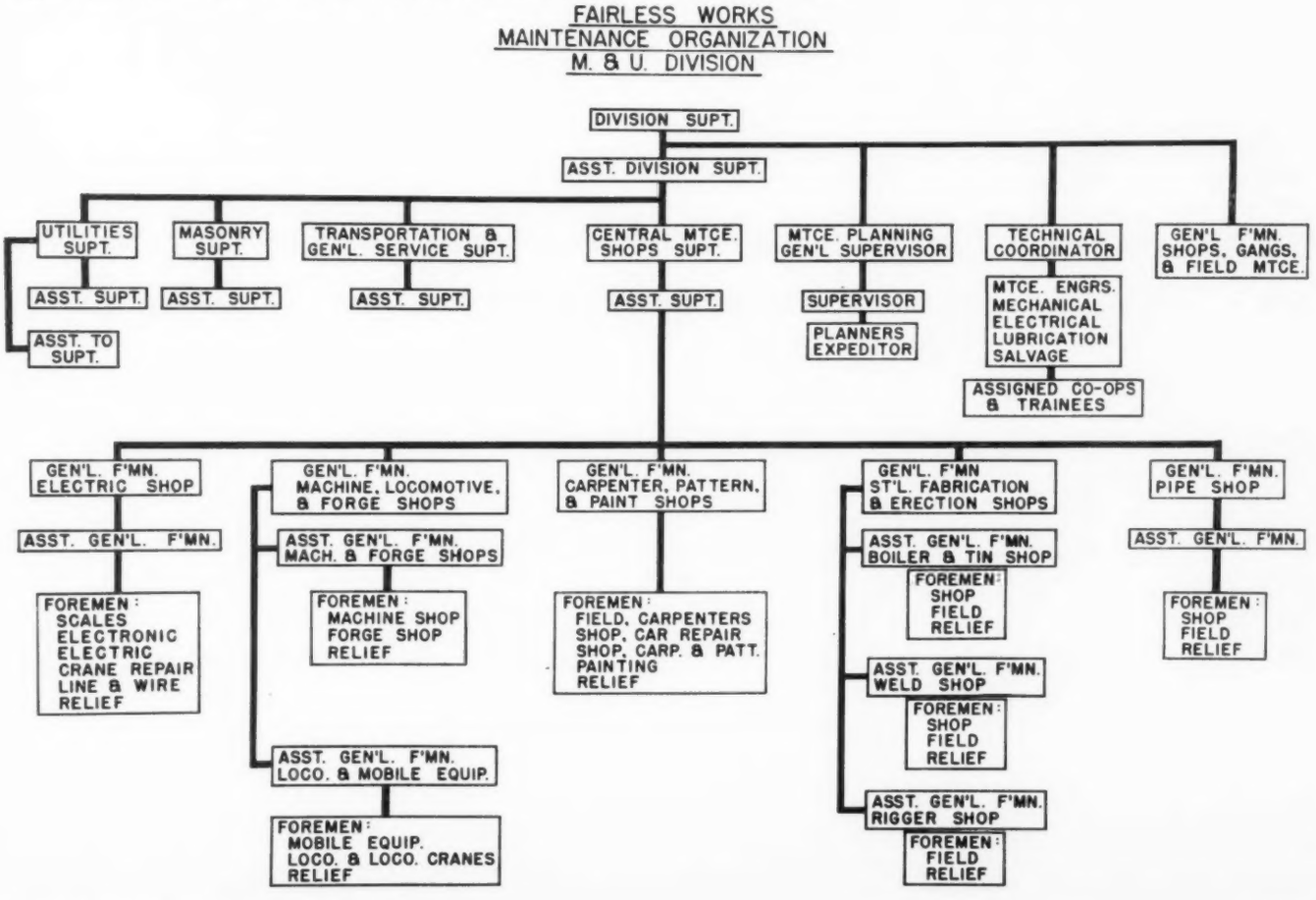


Figure 5 — The above organization manages the affairs of the craft shop.

pipe fitters, instrument repairmen, welders, electronic repairmen, machinists and others. These specialists augment the area maintenance forces where specific skills are needed. The requirements of individual departments are not great enough to efficiently employ craftsmen in each area. The answer to this problem is to group special crafts under an organization called the central maintenance shops, which sells its services to all departments. These shops are housed in a central building geographically located close to the departments of greatest demand.

As shown in Figure 3, the central shops building consists of three bays, each having access to truck and railway transfer points. In the east bay are located the carpenter, paint, pipe, rigger, weld, structural and forge shops. The center bay houses bulk spares, valued at

Figure 6—This chart shows the complete organization structure for the shops.


FAIRLESS WORKS
MAINTENANCE ORGANIZATION
M. & U. DIVISION
DIVISION SUPT.
ASST. DIVISION SUPT.
UTILITIES SUPT.
MASONRY SUPT.
TRANSPORTATION & GEN'L. SERVICE SUPT.
CENTRAL MTCE. SHOPS SUPT.
MTCE. PLANNING GEN'L SUPERVISOR
TECHNICAL COORDINATOR
GEN'L F'MN. SHOPS, GANGS, & FIELD MTCE.
ASST. SUPT.
ASST. TO SUPT.
ASST. SUPT.
ASST. SUPT.
ASST. SUPT.
SUPERVISOR
PLANNERS EXPEDITOR
MTCE. ENGRS. MECHANICAL ELECTRICAL LUBRICATION SALVAGE
ASSIGNED CO-OPS & TRAINEES
GEN'L. F'MN. ELECTRIC SHOP
GEN'L. F'MN. MACHINE, LOCOMOTIVE, & FORGE SHOPS
GEN'L. F'MN. CARPENTER, PATTERN, & PAINT SHOPS
GEN'L. F'MN ST'L. FABRICATION & ERECTION SHOPS
GEN'L. F'MN. PIPE SHOP
ASST. GEN'L. F'MN.
ASST. GEN'L. F'MN. MACH. & FORGE SHOPS
ASST. GEN'L. F'MN. BOILER & TIN SHOP
ASST. GEN'L. F'MN.
FOREMEN: SCALES ELECTRONIC ELECTRIC CRANE REPAIR LINE & WIRE RELIEF
FOREMEN: MACHINE SHOP FORGE SHOP RELIEF
FOREMEN: FIELD, CARPENTERS SHOP, CAR REPAIR SHOP, CARP. & PATT. PAINTING RELIEF
FOREMEN: SHOP FIELD RELIEF
FOREMEN: SHOP FIELD RELIEF
ASST. GEN'L. F'MN. WELD SHOP
FOREMEN: SHOP FIELD RELIEF
ASST. GEN'L. F'MN. LOCO. & MOBILE EQUIP.
ASST. GEN'L. F'MN. RIGGER SHOP
FOREMEN: MOBILE EQUIP. LOCO. & LOCO. CRANES RELIEF
FOREMEN: FIELD RELIEF

F-20066 REV. 253
UNITED STATES STEEL CORPORATION

CENTRAL MAINTENANCE ORDER REQUEST

SHOP ORDER NO.	SUBS	
40910		ROLLING DIVISION - SOAKING PITS

DATE	COST CENTER	W.C. & E. CODE	EQUIP. CODE	APPRO. NO.	APPRO. ACCT.	CHECKED ACCT. DEPT.
7/15/58	4110	3130/3199	332			

QUANTITY	DRW'G NO'S WITH REVISION INVOLVED	TO BE USED FOR
1	GENERAL ASSEMBLY E-104473 & DETAILED PRINTS	#46 CRANE - SOAKING PITS

REQUESTED DELIVERY DATE	CASTING NO.	SPARE PART NAME, NO. & LOCATION	SHIP TO TRUCK STATION NO.
10/15/58		TELESCOPE	SOAKING PIT

DESCRIPTION

FURNISH LABOR AND MATERIAL TO REPAIR TELESCOPE ASSEMBLY FOR #46 CRANE - SOAKING PITS. THE FROZEN CENTER TUBE AND PLAY BETWEEN TUBES INDICATES THE NEED FOR A GENERAL OVERHAUL AND REPLACEMENT OF LINERS.

ORIGINATOR M. FLETCHER SUPT. R. E. MADDEN DIV. SUPT. T.D. CLIFFORD

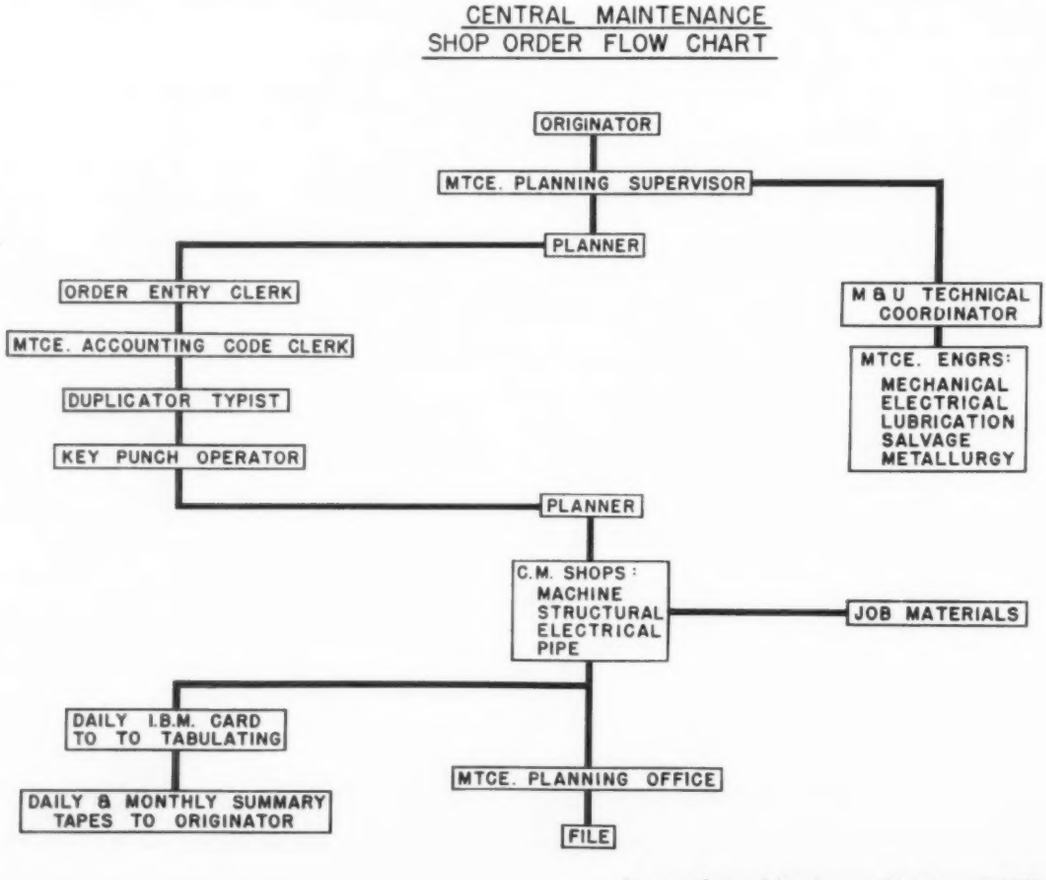
PLANNED YES NO ESTIMATE COMPLETION DATE INITIALS

Figure 7—Area maintenance supervisors initiate a shop order when central maintenance assistance is required.

$2,500,000, that must be stored under roof or require the services of an overhead traveling crane. The west bay contains the line and wire, motor repair, electronics, refrigeration and machine shops. Each is a modern, self-sustaining shop, as shown by a view of the machine shop, Figure 4. The equipment available to the machinist ranges from a simple key seater to a horizontal boring mill with an 8-in. spindle and a 96-in. vertical and lateral travel. All machine tools are arranged for maximum efficiency of space and personnel.

An organization similar to that shown in Figure 5 was established to manage the affairs of such a shop. This is

Figure 8—This chart shows the flow of a shop order through the technical, planning, accounting, and shop departments.



MAINTENANCE PLANNING FORM

Doc.	Shop Order No.	Sub	Date
2	40910	45	8-21-58

ACCOUNT CHARGED – APPROPRIATION

To C.C.	Wks. Cost	Equip.	Codes	Number	Account
4110	3199	23	332		

Act. Hrs.	Dng. or Casting No.	Rev.	Pcs. Req.	Mat'l Amt.
	MARKED E-104425	1	1	

Mat'l Description - Use - To Cost Center Name
REPAIR TO SHEAVE HANGER MK 2
TELESCOPE #46 CRANE, 45" MILL

Signed
FLETCHER

MAINTENANCE CONTROL CHANGES
MARKED DRAWING
SHOWS FABRICATION & INSTALLATION
OF T1 STEEL REINFORCING PLATES ON
O.D. OF SHEAVE COVER.

FOLDER FORWARDED DATE	PLANNED BY	APPROVED
	LARRY	W. E. RIGOT

COST CENTER	OPERATION NO.	OPERATION	SCHEDULE	EST. TIME
	NOTE: NOTE:	ASSEMBLY IN MACHINE SHOP 1. CHECK BRG. RACE, REMOVE IF REPAIRS ARE REQUIRED.		
	NOTE:	2. CHECK 6" BORE ON DAMAGED SIDE NOTIFY PLANNING IF BORE IS OUT OF LINE OR DAMAGED.		
	SUB 46 MOVE	REPAIRS TO BRG. RACE SHEAVE HANGER TO STRUCTURAL.		
8210	SHOP	"V" OUT CRACKS HEAT & BEND DAMAGED AREA TO ORIGINAL SHAPE.		
STORE ORDER 5/8" T1		STEEL PLATE REGULAR HARDNESS		
8210 8260	SHOP WELD	FABRICATE REPAIR PLATES WELD CASTING AND PLUG WELD BOLT HOLES		
8260	WELD	WELD REPAIR PLATES		
8110	MACHINE	MACHINE SHOP CHECK COVER FLANGE AND REQUEST BUILD UP OF FACE IF REQUIRED.		
	MOVE	TO MACHINE SHOP		

Figure 9—A maintenance planner outlines the repairs and sequence of operation.

typical of the organization structure found in each of our craft shops. The complete organizational chart for the shops is shown in Figure 6.

So far the need for organization, the types of skills necessary, and the management teams involved have been covered. Now it is necessary to co-ordinate these forces on the job.

A typical maintenance job in a steel mill is that of repairing the telescope on a soaking pit crane. The crane's erratic operation indicates the need for major

Figure 10—Shop cost accrual cards are made for each operation.

UNITED STATES STEEL CORPORATION
SHOP ORDER LABOR OR MATERIAL CARD

SOURCE	OPERATION NO.	DESCRIPTION
8210	SHOP	"V" OUT CRACKS HEAT AND BEND DAMAGED AREA TO ORIGINAL SHAPE.

DOC	SHOP ORDER NO	SUB	DATE
2	40910	45	8-27-58

ACCOUNT CHARGED – APPROPRIATION

TO C C	WKS COST	EQUIP	CODES	NUMBER	ACCOUNT
4110	3130 3199	23	332		

ACT HRS	DNG OR CASTING NO	REV	PCS REQ	MAT'L AMT
6-S	E-104425			

MAT'L DESCRIPTION – USE – TO COST CENTER NAME
REPAIRS TO SHEAVE HANGER MK 2
TELESCOPE #46 CRANE 45" MILL

SIGNED

TOTAL HOURS | EMPLOYEE NO | HOURS | DATE – TIME | F S F S F S F S F S F S F S

CREDIT ACCOUNT				REFERENCE			DEBIT ACCOUNT – APPROPRIATION						ACT HOURS	AMOUNT	
FROM	*	OPERATION NO.	DOC	SHOP ORDER NO.	SUB	TO C C	WKS COST	EQUIP CODE	APPROP NO	APPROP ACCT					

883777 GW 16208 REV 156

maintenance. The job is too large in scope for an area maintenance organization to handle alone, the central shops, therefore, must become involved. Riggers, crane repairmen, machinists and pipe fitters will be needed. The most important fact to remember is that the determination of whether the job is to be done or not is the responsibility of the area maintenance head. He, in turn, confers with his supervisors to discuss costs, effects on budgets, outage time and effects on production. The operating department superintendent, the area maintenance superintendent and the division superintendent of the department concerned are charged with the responsibility of making the final decision to remove the unit from service and spend the money for repairs. This procedure will vary depending on the importance of the job and its emergency status.

A maintenance planning group schedules and plans all work done by the central shops craftsmen. This group receives requests from area maintenance supervisors. Planning assigns priority to the requests and schedules the jobs to insure orderly progression through the shops.

In the case of our soaking pit crane telescope, the procedure would work as follows. The area maintenance supervisor writes a shop order, Figure 7 specifying what the job is, when it may be done, prints involved and any special details that would aid in the planning of the job. Figure 8 shows the routing of the shop order. When the planning office receives the order, it is recorded and one copy is sent to the maintenance division technical staff for review by the maintenance metallurgist and the maintenance engineers. One or more planners are assigned to spell out the shops involved, the work to be done by each shop, and arrange for pertinent materials necessary for the job. In some cases, this is as simple as picking up the necessary spares from the department. In others, arrangements must be made for outside purchases. Figures 9 and 10 show a planning form and a shop cost accrual card for the soaking pit crane job. Prior to the start of this job, as with any *major* repair, a meeting is held between maintenance planning, the general foreman of the shops involved, the field general foreman of shops and gangs and the operating department heads. If the repair is of major consequence, representatives will be called in from the maintenance division technical staff, plant engineering and the utilities department. At the meeting decisions are made on the following:

1. Scope of job.
2. Safety.
3. Material location.
4. Area responsibility.
5. Shop responsibility.
6. Timing.

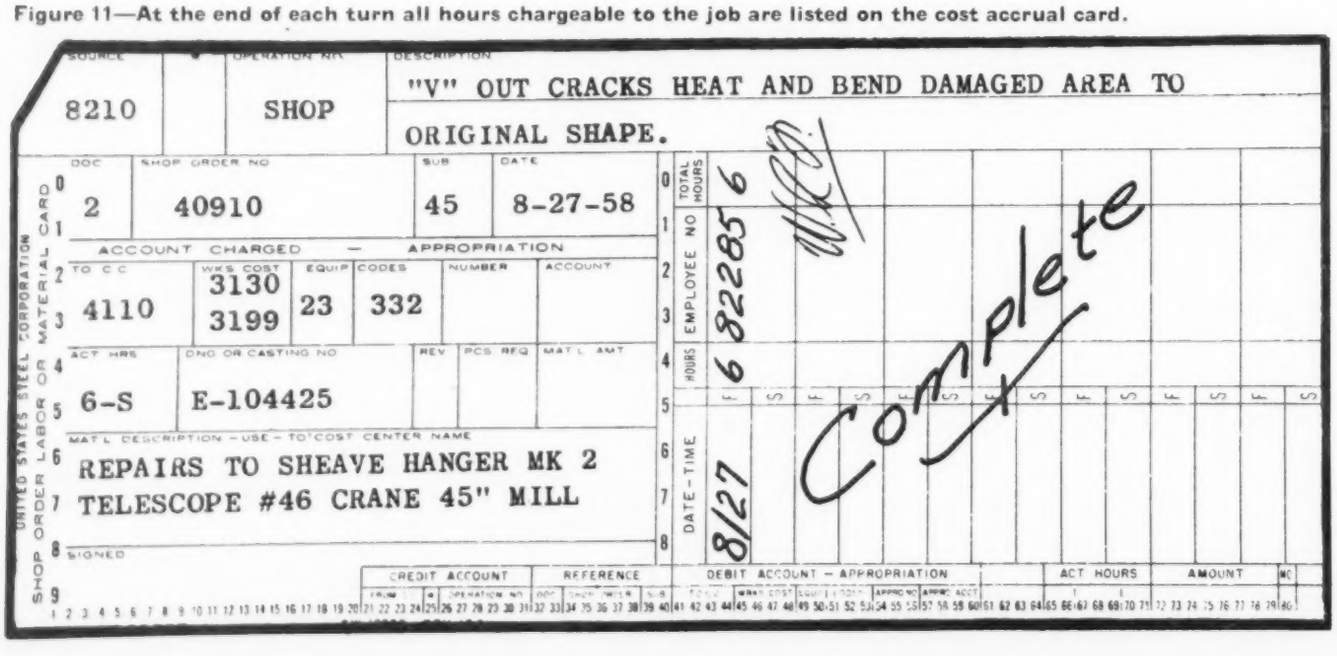
For jobs routine in nature and of lesser importance, the area maintenance supervisor will write the shop order request and deal directly with shops planning and the shop foreman.

Once a job is started by the shops, all charges are available to the originator on a daily basis. This is done in the following manner. At the end of the turn all hours chargeable to the job are listed on the cost accrual card, Figure 11. These cards are collected daily and sent to the key punch machine to be entered on IBM cards. From this point, a standard IBM system is used to issue daily tapes which are sent to the operating areas. A summary tape is also published weekly and monthly. Finally, all shop charges are collected and posted on the area's monthly cost statement.

The key to successful completion of a job is planning and communication. At Fairless Works this is accomplished by close association of the principals involved. On Wednesday of each week, all heads of area maintenance, central shops, maintenance planning and the technical staff meet to review shop hours required for the upcoming week. In addition, common problems are discussed and information received from the corporation maintenance planning committee is disseminated.

The United States Steel Corp. maintenance planning committee is composed of maintenance representatives from each of the major divisions in the corporation. Each steel-producing plant sends one representative of division superintendent status to formulate and discuss

Figure 11—At the end of each turn all hours chargeable to the job are listed on the cost accrual card.



CENTRAL MAINTENANCE
MANAGEMENT TRAINEE SCHEDULE
(3 WEEKS)
(PARTIAL SCHEDULE)

	TIME
1. INTRODUCTION	1 DAY
A. RESUME	
B. SAFETY REGULATIONS	
C. DIVISION ORGANIZATIONAL CHART	
2. PLANNING SECTION	1 DAY
A. CENTRAL MAINTENANCE ORDER REQUEST	
B. METHOD OF PROCESSING REQUESTS	
C. SCHEDULING	
D. FOLDER CONTENTS	
3. ELECTRICAL SHOPS	4 DAYS IF ELEC. MAJOR 2 DAYS IF MECH. MAJOR
A. SCALE REPAIR	
B. CRANE REPAIR	
C. REFRIGERATION	
D. LINE AND WIRE	
E. MOTORS AND GENERATORS	
F. ELECTRONICS	

Figure 12—This chart shows a partial schedule for the routing of trainees through the central maintenance shops.

major policy decisions. The weekly and monthly meetings have one basic purpose in mind, communication. Without communication a sound progressive maintenance program is lost.

To maintain maximum efficiency in the production of steel, facilities such as furnaces, rolling mills, machines and tools must be kept in good operating condition. Co-ordination of maintenance and production work can never be realized without planned programs. Highly trained, well equipped personnel are necessary to initiate these programs. This requires training, from the top management man to the man in the shop. Special courses must be offered for apprentices, area maintenance men, craftsmen and management personnel.

The United States Steel Corp. firmly believes that the sustenance and growth of the industry is dependent upon the success of developing and maintaining competent managerial forces. The campuses of colleges and the personnel brought up through the ranks offer the best potential prospects. In support of this view, the corporation actively participates in "on-the-campus" recruiting of college graduates and internal training courses designed to upgrade personnel.

The proper training program and initial job assignment are of the utmost importance. Our particular program for graduate engineers is a 2 year training program designed to introduce the maintenance engineer to the equipment, tools, conditions, problems, policies and people with whom he must work.

The first six months of the trainee's program are spent familiarizing himself with the responsibilities and functions of each department in the plant. Figure 12 shows a typical routing through one department. He attends special indoctrination classes where the top management people of the department discuss their operational responsibilities. Safety, production rates, equipment, general costs and labor relations are studied. Approximately four weeks are spent in each of the major divisions of the plant during this period. At the end of this period the trainee is interviewed by the division superintendent of the areas in which he is interested. When selected for an area, the trainee is given additional individual instruction. Specific job assignments are given to the man. These assignments vary in importance, responsibility and time duration depending on his abilities. He is given every opportunity to grow. For 18 months the trainee is instructed and evaluated by the department of his choice.

The direction his career takes at the completion of the 2-year training program will be largely dependent upon his personal capacity and desires. An effort is made to match the individual's interest to the requirements. Whether it be line or staff work, we feel that in the steel industry the rewards are great for the engineer with the will to succeed.

In addition to recruiting college graduates for the management and technical trainee course, the corporation is also interested in the undergraduate students. This is expressed by participation in the co-op program offered at various colleges. The aim of this program is to give the undergraduate the opportunity to get on-the-job training while continuing his education. A co-op program exists at each plant.

There are other programs of equal importance which go into the making of a progressive maintenance organization. Maintenance personnel must be trained to develop the skills necessary for the successful completion of maintenance assignments. Personnel who fall into this category include the apprentices, millwrights, motor inspectors and others.

Apprentice requirements will vary from plant to plant, depending on their manufacturing activity. The apprenticeships offered in any trade are governed by the anticipated need for journeymen and the time permitted by operating conditions for scheduling on-the-job experience and related classroom instructions. The corporation offers apprenticeships in 21 trades. Included in this number are the more commonly known trades of machining, carpentry, pipe fitting and welding. Instrument repair and electronics have been added to the list of apprentice courses available due to the in-

Figure 13—A partial job description for an electronic repairman is shown here.

JOB DESCRIPTION - UNITED STATES STEEL CORPORATION

DEPARTMENT MAINTENANCE — STANDARD CODE 08-08-80-LU-06600

SUB DIVISION ELECTRIC SHOP — STANDARD TITLE ELECTRONIC REPAIRMAN

PLANT FAIRLESS WORKS - CENTRAL OPERATIONS — PLANT TITLE ELECTRONIC REPAIRMAN

DATE JULY 15, 1958 — PLANT CODE 8510-7349 (7349)

PRIMARY FUNCTION

TO INSTALL, REPAIR, CONSTRUCT, ADJUST, MODIFY AND SERVICE ALL TYPES OF ELECTRONIC EQUIPMENT.

WORKING PROCEDURE: (THREE OF ELEVEN PROCEDURES)

1. RECEIVES WIRING DIAGRAMS, DRAWINGS, SPECIFICATIONS AND INSTRUCTIONS COVERING THE SCHEDULED AND EMERGENCY REPAIR, INSTALLATION AND INSPECTION WORK TO BE DONE.
2. ANALYZES ALL TYPES OF CIRCUITS, WIRING DIAGRAMS, AND DRAWINGS AS REQUIRED TO INSTALL, REPAIR, ADJUST, CALIBRATE, CONSTRUCT, MODIFY OR SERVICE ALL TYPES OF ELECTRONIC DEVICES AND SYSTEMS, INCLUDING COMMUNICATIONS SYSTEMS, VARIOUS MILL AND PRODUCTION EQUIPMENT, ELECTRONIC COMPUTING AND CONTROL SYSTEMS, POWER AND DISTRIBUTION CONTROL EQUIPMENT, MEASURING, RECORDING, PROCESSING AND CONTROL DEVICES, INDICATING DEVICES AND GAUGES, ETC.
3. PLANS DETAILS OF WORKING PROCEDURE TO DETERMINE MATERIAL OR REPLACEMENT NEEDS AND SELECTS A LOGICAL APPROACH TO "TROUBLE SHOOTING" AND REPAIR PROBLEMS. ANSWERS TROUBLE CALLS.

40 HOUR SUPERVISORY TRAINING SERIES

	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
8:30	CONTRACT	CONTRACT	CONTRACT	CONTRACT	SUGGESTIONS
10:15	B	R	E	A	K
10 30	METALLURGY	METALLURGY	METALLURGY	METALLURGY	METALLURGY
12:15	L	U	N	C	H
1:15	HUMAN RELATIONS	HUMAN RELATIONS	HUMAN RELATIONS	INSURANCE	SAVINGS
3:00	B	R	E	A	K
3:15 TO 5:00	COSTS	COSTS	COSTS	SAFETY	SAFETY

Figure 14—All supervisors attend yearly a 40 hr seminar. During this time they are completely divorced from plant activity.

creased emphasis placed on these fields. The position of electronics repairman has recently been established, Figure 13. Apprentices are normally accepted in the program each year to meet the anticipated openings created by advancement or retirement of journeymen and operational expansion. To qualify for the program the prospective apprentice must compete with other applicants in intelligence, physical fitness and aptitude for the trade that he plans to master. These qualities are measured by examination and interviews. The length of the apprenticeships varies from two to four years, depending on the degree of skill required to qualify him as a journeyman. This training time is divided into periods of 1040 hours, and advancement to the next period is based on examinations and performance standards.

During the course of the apprenticeship a calculated number of hours must be spent on related instruction, which is generally given in a class room. This instruction provides the apprentice an opportunity to study mathematics, blueprint reading, physics, shop theory and the basic economics of business. It has been found that a need exists for specialized training over and above that which a senior journeyman can give to the apprentice. At Fairless Works this related instruction is currently being taught by an assistant professor of the department of graphics, School of Engineering, Princeton University. In addition, specialists from many industrial fields are periodically invited to conduct classes showing how their equipment is constructed, maintained and repaired. Upon successful completion of an apprenticeship, the apprentice receives a certificate signifying his journeyman status in a particular trade or craft.

Up to this point the training of area maintenance forces, skilled craftsmen of the specialized shops and the developing of qualified maintenance management have been discussed. There is one final step in any training program that must not be overlooked, the advanced training of supervisors on a periodic basis. Additional education is necessary even though a man is assigned as a member of plant management. To broaden our management people we have the following programs:

1. One-day specialized seminars aimed at particular problems.

2. Numerous courses offered by area colleges and engineering associations. These are attended by almost every plant supervisor at one time or another in his management career.

3. Sponsored educational programs offered by area institutions on a night school basis.

4. Three to six months general administrative training at accredited colleges to prepare candidates for top administrative positions.

5. All supervisors attend yearly a 40-hour seminar which is aimed to refresh the man on company policies, procedures, industrial relations and other items important for sound management.

Figure 14 shows the 1959 schedule for the 40-hour yearly seminar.

In addition contacts between each management man and his supervisors, plus educational programs undertaken independent of company sponsorship, provide a well rounded management program that occupies some part of every supervisor's day.

In the final analysis the working forces and the training programs supply the managers required to effectively operate a maintenance department which will permit maximum production at minimum cost. Without training, organization cannot be realized. Without organization, profits are lost.

Discussion

PRESENTED BY

PAUL F. WALKER, Assistant to Superintendent, Service Div., Bethlehem Steel Co., Bethlehem, Pa.

C. F. McCLURG, Assistant Division Superintendent, Maintenance and Utilities Div., Fairless Works, United States Steel Corp., Fairless Hills, Pa.

M. B. ANTRIM, Manager, Engineering-Construction, Lukens Steel Co., Coatesville, Pa.

R. H. TURNER, Chief Electrical Engineer, United Engineers & Constructors, Inc., Philadelphia, Pa.

WILLIAM KOWALSKY, Vice President, J. R. Miller Co., New York, N. Y.

Paul F. Walker: What is the elapsed time between the origination of an order that goes to planning and the final placement of the order?

Also, I would be interested in knowing what per-

centage of the maintenance dollar cost is controlled through such planned orders.

On these orders do you estimate or attempt to estimate accurately the cost of the jobs, and what is your box score on the results?

In regard to training, what levels of supervision are included in the program, and do you go down to and include first line foremen in the 40-hr seminars?

C. F. McClurg: The elapsed time between the origination of an order and the final placement varies to a considerable degree. A maintenance organization would be very difficult to operate if every job had to be done immediately as soon as the order came in. We must have a backlog of orders to successfully plan. There are many factors that enter into the speed with which an order is planned and ready for placement in the shops, urgency (whether order is a breakdown), availability of material and backlog in shops, needed to process orders.

Regarding the percentage of the maintenance dollar cost that is controlled through planned orders I would estimate first that 70 per cent of orders are planned. The total dollars represented by this 70 per cent is approximately 20 per cent of the total dollar cost.

We do not attempt to accurately estimate cost of all jobs; however we do use previous experience for repetitive jobs as a means of estimation. On jobs that we do attempt to accurately estimate the estimates compare very well with the actual cost.

Regarding the scope of our training program we do go down to and include all front line foremen in our yearly 40-hr seminars. To a large extent the primary value of this program is in educating the front line foreman so he can perform his duties in an effective manner.

M. B. Antrim: At our plant we continually experience a difficulty in regard to the collection of costs. In the talk it was mentioned that daily tapes of all maintenance costs, and subsequently a weekly and monthly tabulation lumping these costs, itemized with reference to the work order to which they apply were forthcoming.

I would assume from the remarks that the daily tape is available shortly after the work occurs, and it would be of interest to know whether this is a consistent performance or whether the timing of the presentation of the daily tape would vary with the time of the accounting period and consequent work load in the cost and tabulating department. Obviously, if the timing is delayed, the daily tape is of very little aid for control purposes. I would appreciate it if the author would enlarge upon this point.

C. F. McClurg: The tapes for the previous day are available about noon the following day except on the weekends. These tapes contain all pertinent information for proper control. Generally by noon the following day, both shops and area maintenance know what orders were worked on, the time spent on each, and the dollars charged. Tapes for Saturday and Sunday are not available until late Monday. In our case this is not too serious since total hours scheduled and charged on the weekends are light compared to normal week days.

R. H. Turner: In connection with this stripper crane, it occurs to me that when you start out you have a very accurate estimate of the time required and the money necessary for the repairs—and as work progresses, you get a daily report of the hours expended and the money expended. However, in the course of repairs I can visualize the possibility that you may find more trouble than you anticipated. Are there any means of the plant or division superintendent knowing exactly what the physical progress of the repair is from day to day? Is it broken down into various components so that he can see each day whether or not he is running over on a particular part of the work? In other words, without that you could have a case of where you are keeping within your amount of hours and money expended, but when you get the money all used up the job is not done. What means do you have of controlling this?

C. F. McClurg: In the planning of a small job where only one order exists, it is not difficult to know whether we are running over and where the over-run is. On larger jobs the total job is broken down into different components as sub-orders of main order. This gives a better control on the larger jobs. When more trouble is found than was anticipated, there is no alternate but to make the additional necessary repairs. This can, however, be minimized by thorough inspection before starting planning of the work. On large jobs where more extensive repairs than anticipated are necessary, the shop general foreman and the area management determine the additional scope necessary to complete the repair.

William Kowalsky: I have a few questions which I would like the author to comment on:

1. How many people are on the maintenance payroll, and what percentage of the total plant personnel does this represent?

2. What percentage of the selling price for any given steel product represents maintenance cost?

3. Can the area foreman compare the cost estimate for a job from central maintenance with a bid from an outside contractor? Does he have any choice in the selection of the one to do the work? How do central maintenance job costs compare with those of outside contractors?

4. Would Mr. McClurg indicate some of the considerations that led to the adoption of the maintenance organization he described, rather than one either more or less centralized.

C. F. McClurg: The total plant and maintenance population varies with the rate of operation; however, a round figure of total population is 5000 of which about 25 per cent are maintenance people. The maintenance cost as a per cent of selling price will have considerable variation, I would say anywhere from possibly 15 to 25 per cent.

Comparing cost estimate of a job with outside contractors is very difficult and, with some exceptions, is not done. On jobs that can be planned and where tools and equipment are available, cost is competitive with outside purchase.

Whether a plant maintenance organization is centralized, de-centralized, or some place in between is a subject that has had considerable discussion. I do not feel one can say centralized is better or worse unless you consider the plant layouts, the comprehensive organizational setup and many other factors. ▲

Production of Di-Ammonium Phosphate

by Chelsie K. Pearson,
Assistant General Plant Foreman,
Coke and Coal Chemicals Dept.,
The Colorado Fuel and Iron Corp.,
Pueblo, Colo.

. . . . the recent availability of relatively pure phosphoric acid in commercial quantities made practical the production of crystalline di-ammonium phosphate fertilizer in a standard ammonia saturator . . . .

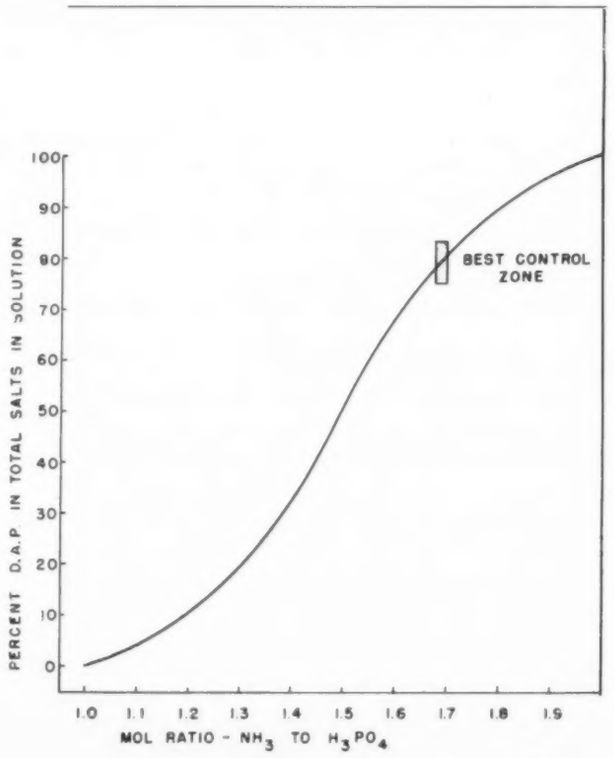
ONE of the steps in by-product recovery in the chemical section of a coke plant is the recovery of the ammonia present in the raw gases. Practically all of the ammonia recovery in by-products plants has been as ammonium sulphate, in a reaction vessel called a saturator. Prior to the construction of high-tonnage anhydrous ammonia plants and increased tonnages in other nitrogen fertilizer plants, this ammonia recovery had always been accomplished at a profit to the by-product plants. As the new ammonia producers flooded the market, the price of ammonium sulphate tumbled until the by-product plants showed little if any profit in their ammonia recovery operations.

Faced with an operating loss in the manufacture of ammonium sulphate, The Colorado Fuel and Iron Corp. in 1954 investigated the feasibility of producing a di-ammonium phosphate fertilizer and started commercial production in December, 1954. Removal of the ammonia from the gas is a necessary step in the preparation of the gas for light oil recovery and for use as fuel gas, so the ammonia must be removed from the gas or destroyed in some manner regardless of the cost of the operation.

Food grade mono-ammonium phosphate and di-ammonium phosphate have been produced for many years in reactor type vessels, using anhydrous or liquid ammonia and food grade phosphoric acid as the raw materials. So far as known, this was the first successful attempt to produce di-ammonium phosphate on a commercial scale utilizing the ammonia from coke-oven gas. Some years ago, a pilot plant trial is reported to have been successfully made at one of the southern coke plants, but no commercial production followed these trials.

It should not be inferred that no attempts had been made to produce phosphate salts at coke plants; many trials have been made, but without success. They failed

Figure 1 — This curve shows the relationship between the mol-ratio of ammonia to phosphoric acid and the percentage of di-ammonium sulphate resulting therefrom.



because the proper quality of phosphoric acid was not available. Until recent years the only phosphoric acid available in commercial quantities was so-called "wet-process" acid. This crude acid contains many metallic impurities, and when reacted with ammonia, the metallic hydroxides and phosphates are formed along with the ammonium phosphates. The resultant precipitate is fine and gelatinous and extremely difficult to filter. The availability of "electro-thermo phosphoric acid," an acid quite free from impurities, has made the production of crystalline di-ammonium phosphate possible in the standard ammonia saturator.

When sulphuric acid and ammonia are reacted in a saturator, one salt only, ammonium sulphate is formed.

$$2NH_3 + H_2SO_4 \rightarrow (NH_4)_2\,SO_4$$

This is not the case when phosphoric acid is used, for several combinations of this acid with ammonia are possible, their exact nature depends upon a number of variables. For example, one molecule of ammonia may unite with one of acid to form mono-ammonium phosphate; two molecules of ammonia and one of acid will form the di-salt, both of these being stable salts at normal temperatures:

$$NH_3 + H_3PO_4 \rightarrow NH_4\,H_2PO_4$$

$$2NH_3 + H_3PO_4 \rightarrow (NH_4)_2\,HPO_4$$

Under certain conditions, however, unstable salts may be formed, either the tri-ammonium phosphate or a compound salt consisting of the di- and tri-salts:

$$3NH_3 + H_3PO_4 \rightarrow (NH_4)_3PO_4$$

$$5NH_3 + 2H_3PO_4 \rightarrow (NH_4)_3PO_4 \cdot (NH_4)_2\,HPO_4$$

Since these two latter compounds, even if formed, would probably have but a momentary life, they will be given no further mention in this paper.

From the preceding formulae it will be noted that the required mol-ratio of ammonia to phosphoric acid is 1 : 1 for the production of mon-ammonium phosphate and 2 : 1 for the di-salt, hereafter referred to as "DAP". A curve showing the relationship between mol-ratio and the percentage of DAP formed is shown as Figure 1. Between these ratios, various proportions of the mono- and di- salts are formed, they being in a 50-50 proportion at a mol-ratio of 1.5 : 1. On this curve the zone of best control is shown as between 1.68 and 1.70 mol-ratio at which point the solution is indicated as containing 80 per cent di- and 20 per cent mono-ammonium phosphate. When a solution of a mixture of salts such as this is built up to super saturation, the salt which is present in the greater proportion will crystallize out of the solution, the salt in lesser proportion contaminating such crystals to a negligible degree. The removal of the DAP crystals does not result in an increase in the proportion of the mono-salt if the mol-ratio is held constant. The mono-salt, in excess of the theoretical proportion, will be converted to the di-salt according to the formula:

$$NH_3 + NH_4H_2PO_4 \rightarrow (NH_4)_2\,HPO_4$$

Control of mol-ratio is maintained by adjustment of the pH of the liquor in the bath.

It will be noted that the best mol-ratio for production control at the NH_3 to H_3PO_4 ratio has been established

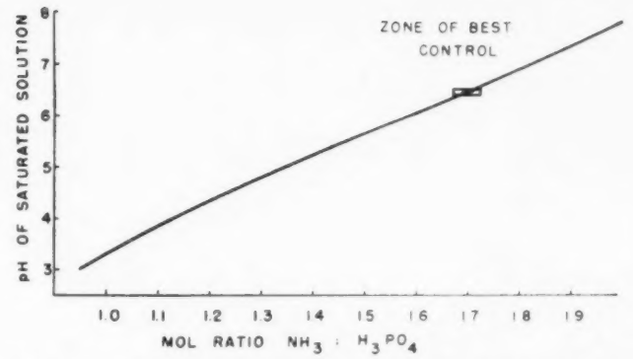


Figure 2 — The pH of the bath for various mol-ratios of ammonia to phosphoric acid are given by this curve.

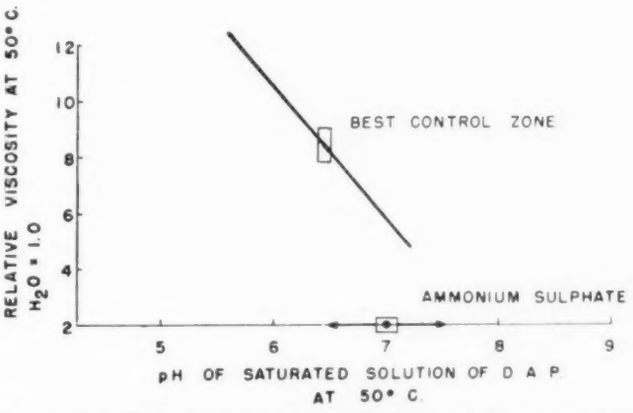


Figure 3 — The viscosity of the solution relative to water (1.0) is a function of the pH of the bath.

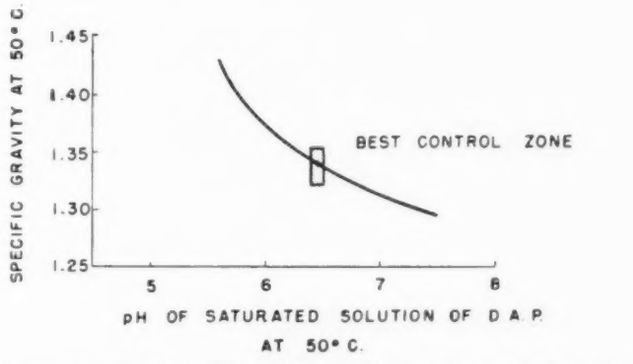
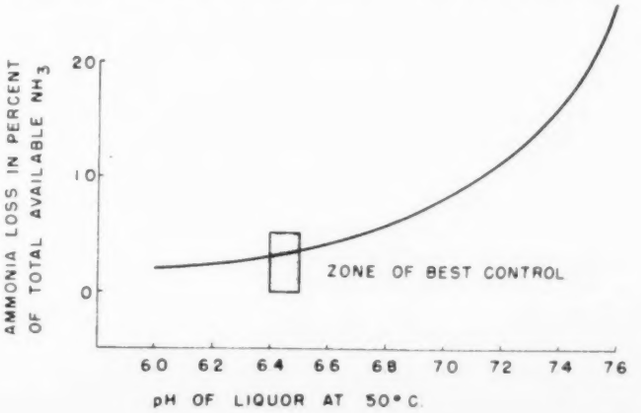


Figure 4 — The specific gravity of the solution is an inverse function of the pH of the solution.

Figure 5 — Loss of ammonia increases with the pH level.



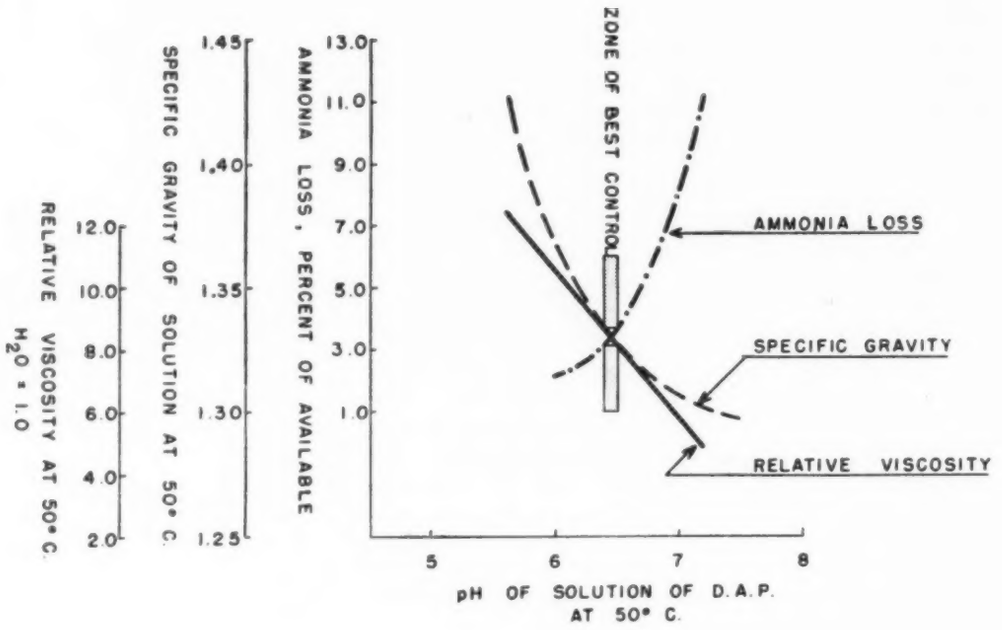


Figure 6 — These curves show why the 6.4 to 6.5-pH range was selected.

within the range of 1.68 : 1 to 1.70 : 1. This, in turn, requires the pH to be held within the limits of 6.4 to 6.5 as shown in Figure 2. At first glance this may appear to present an extremely difficult operating condition, but it has been found that control within these limits is much easier than had been anticipated. Routine pH determinations are made by the use of a standard laboratory pH meter on samples withdrawn from the circulating bath liquor at least every hour. The test is run at 50 C, and the liquor may contain as much as 20 per cent crystals. These tests are continuously checked by a recording pH meter; automatic pH control, however, has been found to be impractical.

The question will doubtless be asked as to why the narrow band of 6.4 to 6.5 pH was selected for control in view of the fact that, as previously stated, DAP can be produced with a mol-ratio anywhere between 1.5 and 2.0 and with a corresponding pH range of 5.6 to 7.6. Certain advantages might be expected to result from establishing a broader control zone, but any apparent advantages are offset by serious disadvantages.

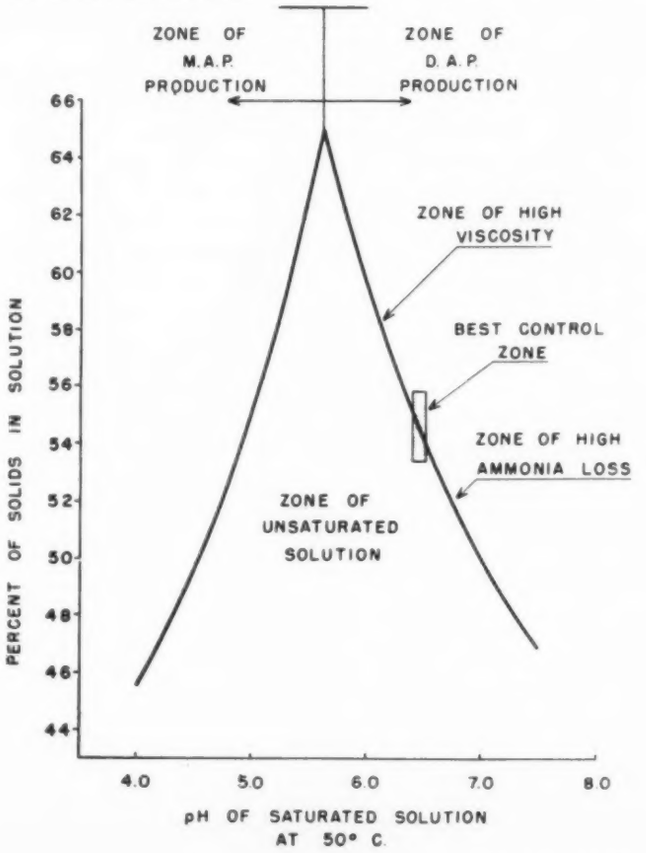
First, the viscosity of the solution must be considered. It will be noted, from the curve in Figure 3, that the relative viscosity, as compared with water, increases as the pH is lowered; at 5.6 pH the solution has a syrupy consistency. Based on this factor it appears that best control would be at a point closer to 7.0 pH. Note also, on this chart, the viscosity of a saturated solution of ammonium sulphate under similar conditions.

The specific gravity of the solution also increases as the pH is lowered and at a more rapid rate; this relationship is shown in Figure 4. The combination of this factor plus that of viscosity would result in a greatly hindered settling of crystals should we operate at a pH of 6.0 or less. Here, again, it appears to be advantageous to operate at the higher pH limits.

The loss of ammonia follows the opposite trend and becomes excessive at the higher pH levels as is shown in Figure 5. This ammonia could be recovered in a secondary scrubber using acid of greater concentration. The 2-stage reaction process is not uncommon when producing di-ammonium phosphate from anhydrous ammonia, but the cost of installing such equipment after our saturators would be greater than could be justified by the elimination of the ammonia loss of five per cent which is encountered under the established operating conditions.

If these three curves are combined on a somewhat different scale and centered at a common point, repre-

Figure 7 — The amount and type of crystals present in the saturator bath at various pH levels depends on the pH of the saturated solution.



senting the zone of best control, the above reasoning becomes somewhat more clear. This data is shown in Figure 6. In Figure 4 the relationship between the pH and the specific gravity of a saturated solution of chemically pure DAP was shown. From this chart it will be noted that the best control zone of 6.4 to 6.5 pH corresponds with specific gravity limits of 1.335 to 1.345; however, the build-up of impurities has increased the specific gravity of the bath so that the process is in the range of 1.350 to 1.360 at a pH of 6.4 to 6.5. Specific gravity checks are run hourly by the operator. The reason for this double check is that pH meters are delicate instruments and can be easily thrown out of calibration, and that the presence of certain impurities in the saturator bath may tend to "buffer" the meter readings and render them inaccurate. It has been found that the double check secured by making this second determination makes the control of the process quite reliable.

The amount and nature of the crystals present in the saturator bath at the various levels of pH are shown in the curve of Figure 7. From 4.0 to 5.6 pH, mono-salt predominates, and this salt would be crystallized should the bath become supersaturated. At 5.6 pH, the mono- and di-salts are present in equal proportions and, theoretically at least, any salt formed at this point should contain equal amounts of each crystal. From 5.6 to 7.5 pH, DAP will crystallize out, but unsatisfactory working conditions are encountered in the high-viscosity zone as shown; the high-ammonia loss zone also is indicated. Therefore, the pH of the bath liquor is controlled within the 6.4 to 6.5 limits. It is possible to do this in a satisfactory manner.

Figure 8 shows a section through the saturator. In this vessel, the gas is fed in through a serrated distributor labeled "Cracker Pipe" underneath the surface of the liquor. The liquor is maintained at the desired pH by the addition of 75 per cent phosphoric acid. About half of the acid is added directly to the saturator and the balance added to the overflow liquor which is then returned through the spray in the top of the saturator.

The purpose of adding acid to the spray liquor is to reduce the pH in this liquor as low as possible and thereby reduce the ammonia lost in the out-going gas. The saturator liquor is constantly circulated, as indicated, with the newly formed crystals being carried in the circulating liquor and the larger crystals settling to the bottom of the saturator where they are picked up in the slurry pump suction pipes. This slurry, carrying up to 40 per cent crystals, is pumped to a settling tank above the centrifugal dryer. The dryer is fed from the bottom of the settling tank and the overflow liquor constantly returned to the saturator. The di-ammonium phosphate comes out of the centrifugal dryer at about two per cent moisture. The filtrate through the dryer is returned to the dryer feed tank and then back to the saturator.

The wet di-ammonium phosphate from the centrifuge is further dried to about 0.1 per cent moisture in a hot air dryer. In this dryer, the salt is conveyed on a mechanically vibrated screen while heated air is blown up through the salt bed. The action of the conveyor and the heated air gives the salt a truly "fluidized" action, and the drying is accomplished very effectively. The moisture in the dried salt is controlled by varying the feed rate, air rate and the temperature of the preheated

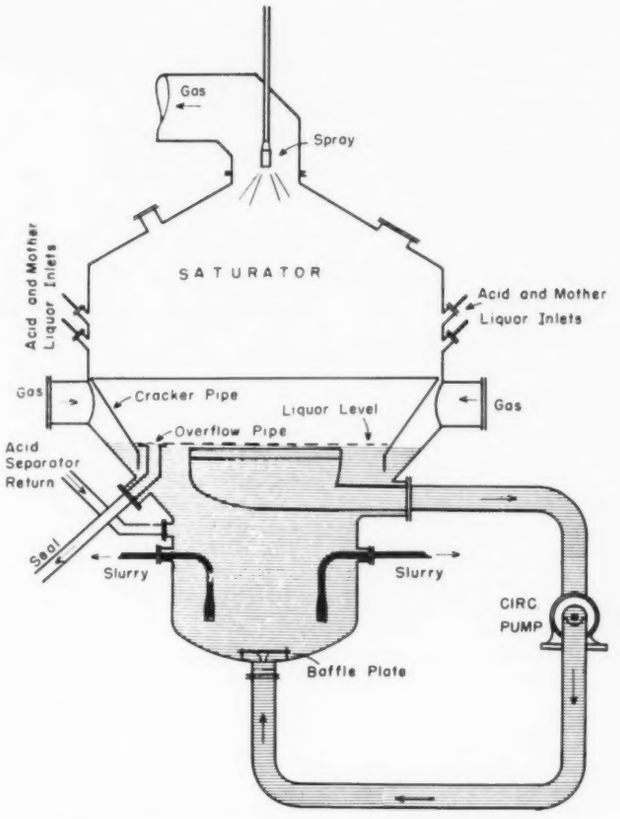


Figure 8 — Section through the saturator.

air. Di-ammonium phosphate will start to break down into the mono salt and release ammonia at a temperature of 158 F. So the air temperature must be held down and a large volume of air must be used to accomplish the necessary drying.

After the salt is dried to about 0.1 per cent moisture, it is fed to our granulating plant where the moisture is increased to about 0.5 per cent by the addition of steam. This moist salt is compacted between smooth rolls into a sheet 20 in. wide by $\frac{1}{8}$ in. thick. The compacted sheet is broken up into large flakes, and the resultant minus 14-mesh material screened out on a screening conveyor which conveys the flake to a spiral elevator. The spiral elevator permits about 5-minutes curing time for the flake to harden and dry before it is introduced to a 2-stand roller mill with corrugated surfaces where the flake is reduced to granules of the desired size. The granules are then screened with the 6 x 14-mesh material going to product, the oversize returning to the roller mill and the undersize being returned to the feed hopper.

After being granulated, the DAP is transferred to storage and is ready for shipment either in bulk or in 50-lb bags, which is our standard shipping container.

As marketed, the DAP will show an analysis of from 20.5 to 21.0 per cent available N_2 and from 53.0 to 54.0 per cent available P_2O_5. This is a very high-analysis fertilizer and is sold to users who require a high P_2O_5 to N_2 ratio for their crops. The sugar beet industry requires such a ratio.

The granules of DAP are quite strong and show little tendency to break down in handling, and have found very good customer acceptance. ▲

Bifurcation of Open Hearth Furnaces

by C. G. Campbell—General Foreman
Open Hearth Dept., The Colorado Fuel and Iron Corp., Pueblo, Colo.

. . . . production was maintained during the 11-month period in which 16 furnaces were bifurcated and a new one installed, by making the changes during general ground rebuilds . . . .

THE decision to change to bifurcated operation at Pueblo came during 1955 after extensive investigation showed that pit cranes were over-taxed due to an increase in the heat size over a period of years. After various plans and methods were investigated, No. 16 furnace was chosen for an experimental test for bifurcation. During a ground rebuild, a bifurcated runner was built, and the furnace pits were converted to accommodate two ladles. For the experiment, nothing else was done to the furnace, Figure 1.

Figure 1 — This furnace was originally built for 115-ton heats.

After the rebuild, the charge was increased in steps from the original 115 tons until the size of heats tapped was 165 to 170 tons. This represents an increase in heat size of approximately 40 per cent.

During the time No. 16 furnace was operated experimentally, planning toward converting the shop exposed many problems. The first of these was to maintain production during the conversion period. Construction in the pit would necessarily block movement of materials back and forth over the construction area. It would also be necessary to block pouring tables immediately behind the construction area. Much of the engineering would have to be done in the field due to the fact that time was of the essence in this program. The pit pouring crews would be faced with the problem of extreme congestion in the pit and with sharing their cranes and other equipment with construction crews. Another factor of prime importance which had to be considered was timing with respect to converting each furnace from single-ladle to double-ladle operation, using the least time for the total conversion program. This problem was resolved when it was decided to convert each furnace during a ground or general rebuild. This, then, would mean that a total of 8 to 12 months would be needed to finish the job, because our general rebuild cycle was approximately 9 months, and there would be some conflict due to more than one furnace being down at the same time for general rebuild.

If bifurcation were applied to all furnaces, the limiting factor of heat size would be the checker and natural draft stack capacity. Through studies it was felt that 130-ton heats could be tapped on furnaces 1 through 15 where heats of 115 tons were being tapped into a single ladle.

No. 3 furnace was the first to be converted in this manner. The additional charge in this furnace proved to be more than the hearth could handle. Many times metal was flushed into the slag pot during the flush period and boils developed on the false banks, which were sorely over-taxed. It was at this time, then, that the decision was made to extend the hearth and place a new rammed bottom on each furnace as it was converted for bifurcation. It was felt also that additional bath capacity could be attained by thinner bottoms and by lowering the tap hole approximately three in.

In review, the following would be the plan for conversion of a furnace: During a ground or general rebuild of a furnace, the cooling pans would be moved toward

the ends of the furnace approximately eight in. A new rammed bottom would be installed. The bottom, of course, would be thinner and the tap hole would be lowered approximately three in. As for the work required in the pit, it would be necessary to remove approximately 700 yards of dirt, and after this dirt had been removed, forms and reinforcing bars would be set to pour approximately 140 yards of concrete which would be accomplished in two or three steps. After 18 to 24 hr of curing, the forms would be removed and the ladle and slag pot stands placed into position. The conversion time for each furnace would be from 9 to 15 days total, depending on other rebuilding that was necessary during the same period. All construction and conversion work would be accomplished by open hearth personnel, equipment and assigned maintenance crews.

With respect to related equipment on each furnace, consider first the bifurcated, or "Y," steel runner. The rigging used to direct the flow of steel is an integral part of the runner. Cable reeved to a small air hoist is used to lift or lower the diverter rod as desired. The horizontal movement is accomplished by pushing or pulling a long rod attached to the diverter rigging beyond the center or fulcrum point. A tile brick of fire clay was developed to enhance the even division of the steel. This point tile is 24 in. high, with its three sides measuring eight in. There is a two-in. hole in the center which accommodates a steel rod that has been welded to the bottom of the runner. The runner is skulled out and made ready for the tap hole on the floor-level platform in back of the south end of the furnace. The additional width of the bifurcated runner at the ends of the legs, or "Y," necessitated extending a section of this platform approximately 2 x 9 ft. It might be noted here that in order to lift the runner, the jib hoist had to be greatly reinforced and cable reeving had to be changed to enable us to use the runner hoist motors that were available. A new dynamic brake also had to be installed to control this heavier load. With the rigging on the runner, it became quite difficult to burn out the plug with oxygen and keep the tap hole straight. Jet tappers, therefore, came into use, Figure 2.

Next, consider the furnace pit and ladle stand construction in more detail. As the floor of the furnace slag pockets was approximately 8 ft below that of the pit floor and pouring table tracks, it was decided to establish three levels in the pit; first, the pouring table trackage would remain the same; second, a concrete pad 14 ft wide would contain a 3-rail track the full length of the pit; third, a floor even with the ladle stands would allow a minimum of ramping into slag pockets in which overshot loaders were to work, and at the same time allow maximum room for bucket clearance of the loader. Proper elevation of this floor level against the vertical wall of the pit track level and the platform extension had to be maintained to assure clearance for the loader bucket.

In order to position the slag pot on the north side of the ladles to receive both flush and tap slag with one setting, it was necessary to design and cast a curved slag runner. This might be considered a field engineered job. Another field engineered job was the designing and fabrication of a manganese chute on the north side of the tap hole platform to accommodate the north ladle, and the changing of position of the south manganese chute to accommodate that ladle.

Figure 2 — Jet tappers were installed.

As previously stated, the steel ladles were capable of holding 115 tons and had to be reduced in size to hold 80 tons by removing 18 in. from the top and 18 in. from the bottom. The reduction of both top and bottom of the ladle was necessary because of clearance between the top of the ladle and the steel runner, and between the bottom of the ladle and the pit wall. Naturally, stopper rod and rigging lengths were reduced commensurately. By redesigning the slag pots, which formerly held 100 cu ft, to pots which hold 230 cu ft, less pit crane time was necessary for handling. Slag pot stands placed on top of the concrete footing were made to insure proper placing of the pots to receive both the flush and tap slag.

The pouring crews in the pit experienced many changes brought about by bifurcation. In order that this can be clear, consider the difference between the old single-level and the present 3-level pit floor, using the floor of the furnace slag pocket as a base.

It is quite evident that the three levels would restrict movement of equipment and supplies into and out of the pit. Further restrictions were placed on storage facilities because the pouring tables had to be extended to allow for the longer trips of stool cars made necessary by the larger heat size. In fact, the distance between each table was reduced by 75 ft, or approximately 50 per cent. The removal of the old slag pot switching facilities, and the change in slag pot handling methods, eliminated the congestion in these areas.

Because each heat now had to be handled by two pit cranes rather than one, the number of pit cranes was increased to four. At this time, it should be mentioned that No. 17 open hearth, a 230-ton bifurcated furnace, was under construction. Due to this, a fifth crane was erected in the pit, and a fifth charging machine was built. Further, it has been determined that a sixth pit crane will be necessary to maintain maximum production. Also, it was considered that five elliptical ladles of 125-ton capacity would be needed to take care of heats from this furnace and No. 16 furnace. With the addition of the five new ladles, the total steel ladles

in the pit was increased to 33. With ladle life virtually reduced to half, an additional ladle relining station was constructed at the north end of the pit to double the relining capacity when needed.

As mentioned previously, No. 17 furnace was being constructed during this conversion of the balance of the furnaces in the shop. This meant that the south end of the shop was virtually blocked, and that so far as the pit was concerned, all furnace debris, dirt and brick had to be removed in broad gage cars through the north end of the pit only. Molds for the steel castings, which are poured at the open hearth, are made up at the casting foundry. These are shipped to the open hearth on flat bed narrow gage cars, and had to be placed at the north end of the pit also.

In order that broad gage cars of scrap could be switched into the stockyard for reloading into pan cars, a new track had to be constructed through the stockyard from the north end. The stockyard unit is responsible for the delivery of scrap to the charging floor, and delivery of the steel ingots from the open hearth pit to the ingot mold stripper and then to the rolling mills soaking pits. This was the least affected of any unit in the open hearth. Trackage on either side of the stripper had to be extended to accommodate the longer trips of stool cars. Additional stool cars were also provided to compensate for the longer trips made necessary by the larger heats. In the face of all of this, production was maintained at a reasonable level.

Maintaining identity of heats and ladles became a 2-fold problem. First, uneven distribution of the steel into the two ladles could possibly cause the ladle analysis to vary to the extent that one ladle of steel might have to be diverted to another grade. Second, many times one heat of steel will be tapped in order to obtain separate specifications in each ladle, through varying the ladle additions such as manganese, silicon, coke, etc. Many plans were considered, and finally a simple one was devised to insure identity and also relieve the rolling mills of any need for equipment changes in order to stamp identity on the rolled products. The north ladle carries the furnace number and heat number. The south ladle carries the reverse digits of the furnace number with the heat number. In the case of single-digit furnace numbers, the number zero is always placed in front of the furnace number for the south ladles. No. 10 and No. 11 furnace numbers are doubled; that is, 20 and 22 for the south ladles on these two furnaces. Figure 3 shows the tapping of a furnace.

Figure 3 — One of the bifurcated furnaces is being tapped.

Bifurcation had its effects on the mason and labor unit, which is responsible for the rebuilding of furnaces. The tearing down and subsequent removal of slag and debris from the slag pocket level of the pit posed problems. Since pocket slag is quite dense, it must be shot with dynamite to break it up for removal from the slag pocket with an overshot loader. The power and stability of the loader made its size such that it is not too maneuverable within the confines of the slag pocket and its immediate outside area. Again it must be stressed that the clearance of the bucket in relation to the platform extension is limited. It must also clear the top of the dirt box which is sitting on the next higher pit level. Experience on the part of the loader operator has minimized this problem, however.

The rebuilding gangs realize a distinct advantage in the new concrete pad, inasmuch as it is level. Fork trucks can use it for transportation of brick. The various levels allow trucks to be used to bring sand for lining the floor of new or cleaned out slag pockets. The trucks dump the sand into a converted ladle on the lower level. The ladle is then transported to the furnace being rebuilt.

The organizational changes brought on by bifurcation occurred primarily in the pit pouring crews. On a 15-furnace schedule, the organization for the old, or single-ladle, operation in the pit consisted of the general pit foreman, a first steel pourer, two second steel pourers, two first ladlemen, two second ladlemen, seven third ladlemen inside, and two third ladlemen in the mold yard, and one ingot shipper. Two men worked in the blacksmith shop straightening used stopper rods. Two men worked in the stopper shed making up new stoppers. There were three pit cleanups and one loader operator.

Now, with bifurcated furnaces, this is the organization: a general pit foreman, a turn pit foreman, one first steel pourer, three second steel pourers, three first ladlemen, three second ladlemen, seven third ladlemen inside and two third ladlemen in the mold yard. We now have two ingot shippers. There are three men working in the blacksmith shop straightening stopper rods, and three men in the stopper shed making up new stoppers. In addition, there are three pit cleanups.

The total difference, then, based on a 15-furnace operating schedule, is the addition of one second steel pourer, one first ladleman, one second ladleman and one ingot shipper in the pouring crews, one additional person in the blacksmith shop, and one additional person in the stopper shed. The front-end loader has been discontinued, and there are still just three pit cleanups.

During this conversion period, August, 1956 to June, 1957, No. 17 open hearth was completed and the first heat was tapped on March 17, 1957. ▲

Open Hearth Slag Handling

by G. R. Morgan, Senior Industrial Engineer,
The Colorado Fuel and Iron Corp., Pueblo, Colo.

. . . . a serious bottleneck is eliminated by using tractor-trailer units to transport slag from the pit pouring tables to the dump site . . . .

FOR several years, the handling and disposing of open hearth slag had been a bottleneck to open hearth operations at the Pueblo Plant. The method and equipment used in handling slag were old, costly and much too slow to keep pace with furnace operations.

Figure 1 is a schematic diagram showing the old method used in the removal of slag from the pit to the slag yard and then onto the dump. As the slag pots became full at the furnaces, the pit cranes would load them for transportation to the slag yard. The pots used were of 100-cu ft capacity, and approximately five were required for each heat tapped. This required considerable pit crane time and led to a great deal of congestion in the pit, as it was necessary to set up and remove the pots as soon as possible after a heat was tapped. Under maximum furnace operations, 75 pots were in service at all times, and approximately 150 to 180 full pot loads were removed from the pit each day.

Two methods were used for this transfer to the slag yard: at the north end of the shop, the pots were loaded onto narrow gage railroad cars holding approximately eight. The pot cars were then switched by a narrow gage locomotive into the slag yard, which was adjacent to the open hearth building and on the east side. The pots from the south half of the pit were loaded onto transfer cars and shuttled directly into the slag yard by overhead cranes.

In the slag yard, three overhead cranes were used to dump and reload the slag for transportation to the slag dump, and three groundmen were employed to hook the cranes and to direct the operation. One crane was used to remove the pots from the railroad cars and the transfer cars and to dump them onto the ground. After the slag had cooled sufficiently to be loaded, the other two cranes, equipped with clamshell buckets, were used to load the standard gage air dump cars. The yard would hold only six air-dump cars at one time, making it necessary to switch them out of the yard at least once each turn. The loaded cars from the previous day's operation were switched daily to the dump, which was approximately 2½ miles south of the open hearth shop. This presented a switching problem, as the train had to travel completely through the plant and through several main switching points in order to arrive at the dump. The complete round trip, including the dumping of cars, usually required five to six hours.

This operation was slow, as the cranes could not load fast enough nor could the cars be switched to the dump fast enough to keep up with the furnaces. This created a great bottleneck in the slag yard, and from time to time, it was necessary to use mobile equipment, such as loaders and trucks, to supplement the slag yard operation.

The slag removal operation, therefore, required the services of a standard gage locomotive and crew, a narrow gage locomotive and crew, three cranemen, and three groundmen on a 21-turn-per-week basis. Not only was the operation costly from a labor standpoint, but considerable maintenance costs were also present, as this type work was very hard on cranes and dump cars.

In the past few years, it became more and more difficult to keep up with the furnace operations. Above all, after the bifurcation of the 16 existing furnaces and upon completion of the new No. 17 furnace, the slag handling facilities would have been completely inadequate. It was therefore imperative that a new, fast,

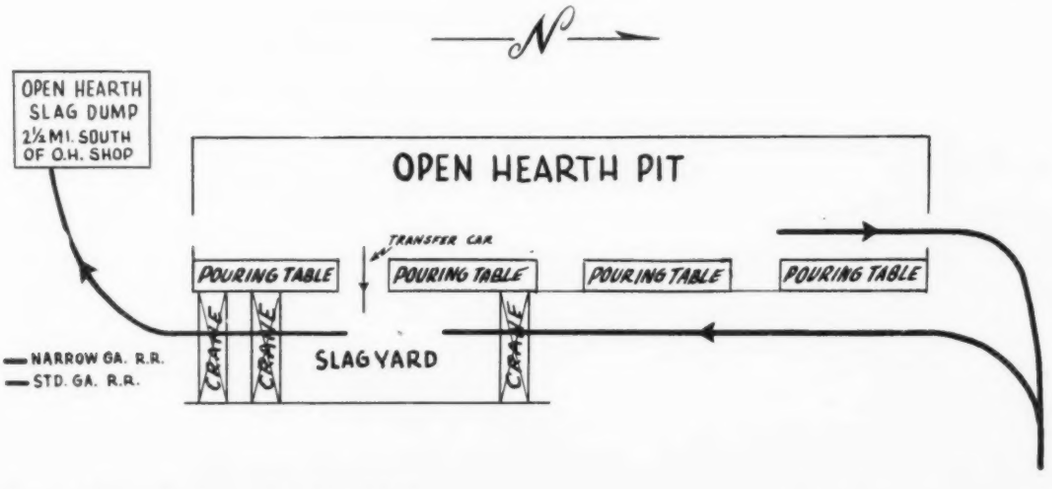


Figure 1 — This schematic layout of the old open hearth facilities shows why the slag handling operation was a bottleneck.

and dependable method of slag handling be developed, which would eliminate this bottleneck. Four major items had to be considered: first, it would be necessary to increase the size of the slag pots in order to reduce the number of lifts necessary by the pit cranes, the number of pots required in service, and the number of loads to be handled in and out of the pit each day; second, to eliminate the slag yard by transporting the pots directly to the dumping site, thus eliminating double handling; third, to relocate the dump much nearer to the open hearth shop to make possible faster switching; and finally, to reduce, if at all possible, the cost of the operation.

Figure 2 shows the first proposal considered. This system was patterned after conventional methods and would have employed railroad facilities. New, larger pots were to be designed, and as the pots became full at the furnaces, the pit cranes were to load them onto standard gage railroad cars which were to be self-dumping. They were then to be switched by a narrow gage locomotive, employing an adaptor coupling, from either end of the pit to a new, closer dumping site east of the open hearth shop. In order to do this, it would have been necessary to design and fabricate new pots, self-dumping pot cars, and to lay a new 3-rail track from the pit to the proposed dumping site, which was approximately $^3/_4$ miles east of the open hearth shop.

This method would have eliminated the slag yard operation; however, in order to approach the proposed dump, it would have been necessary to lay the new trackage through one of the major switching points in the plant. Through this junction, several important items are switched every hour of the day, such as ingots from the pit to the stripper and empty molds back to the mold yard. Scrap, limestone, iron ore and other materials are transferred from a switching yard to either end of the plant. Also, the tracks used for the transportation of hot metal from the blast furnaces go through this point. Rather than adding to the switching problem and possibly having slow transportation of slag to the dump, it was decided to locate the dump elsewhere.

There was one other suitable dumping site, which was close enough to the open hearth shop. However, it would be necessary to cross the main C&S railroad tracks, which run parallel to the east side of the plant. This would have been impossible, using railroad facilities. Only one method could be used to cross these tracks, that being mobile equipment.

At first, there was some question about transporting such extremely heavy loads by mobile equipment. This problem was discussed with heavy duty trailer manufacturers, and it was found that trailers could be constructed to carry almost any capacity load. Therefore, it was decided to use heavy duty trucks to transport the pots to the new dump and remove and dump them with a mobile crane.

In this procedure, Figure 3, large, flat-bottom pots, which would be suitable for truck loading, were to be used. Full pots would be loaded by the pit cranes onto standard gage flat cars and switched to a transfer station, where an overhead crane would transfer them from the cars to the trucks for transportation to the new dump. On the dump, a heavy duty mobile crane would dump the pots and reload the empties for the trip back to the transfer station. As in the previous proposal, railroad facilities also would be used. A 3-rail track would be laid through the pit to the transfer station, and again an adaptor coupling would be installed on the pot cars, so that the narrow gage locomotive could switch them to the transfer station.

This method was decided upon, and new pots were designed and cast. To facilitate fast handling by the pit cranes, the pot size had to be restricted by the lifting capacity of the auxiliary hoist, or to approximately 40 tons when full. Also, the available space at the ladle

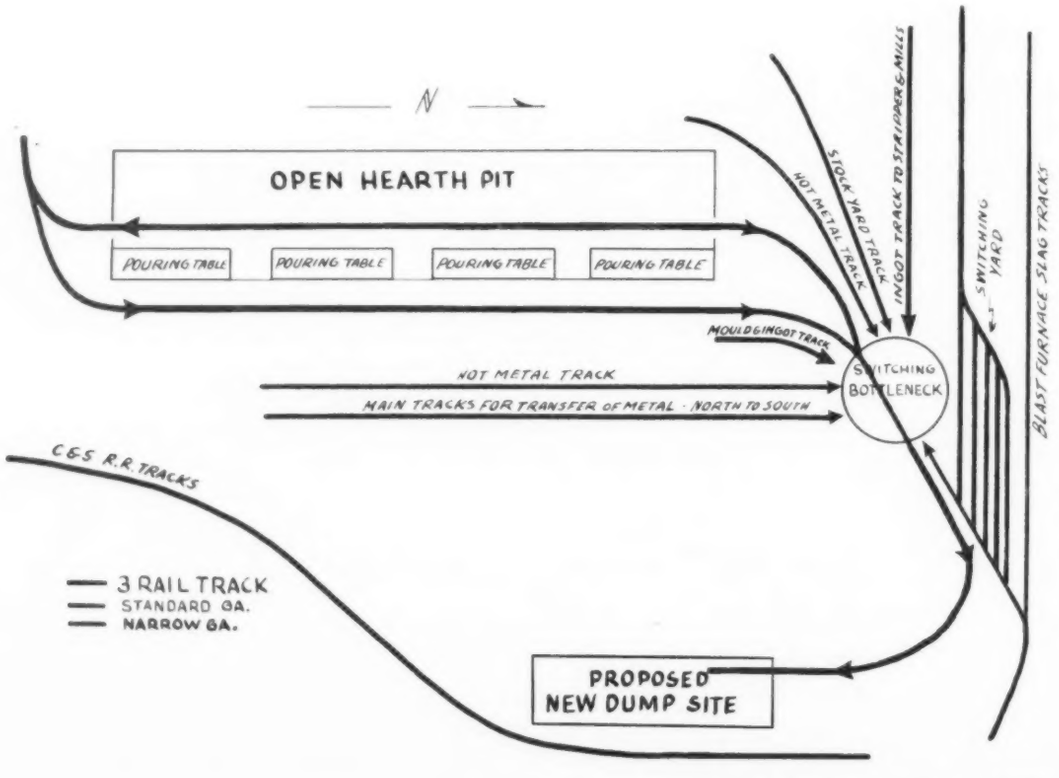


Figure 2 — The first proposal used conventional railroad facilities and relocated the dump site but would have created a switching bottleneck.

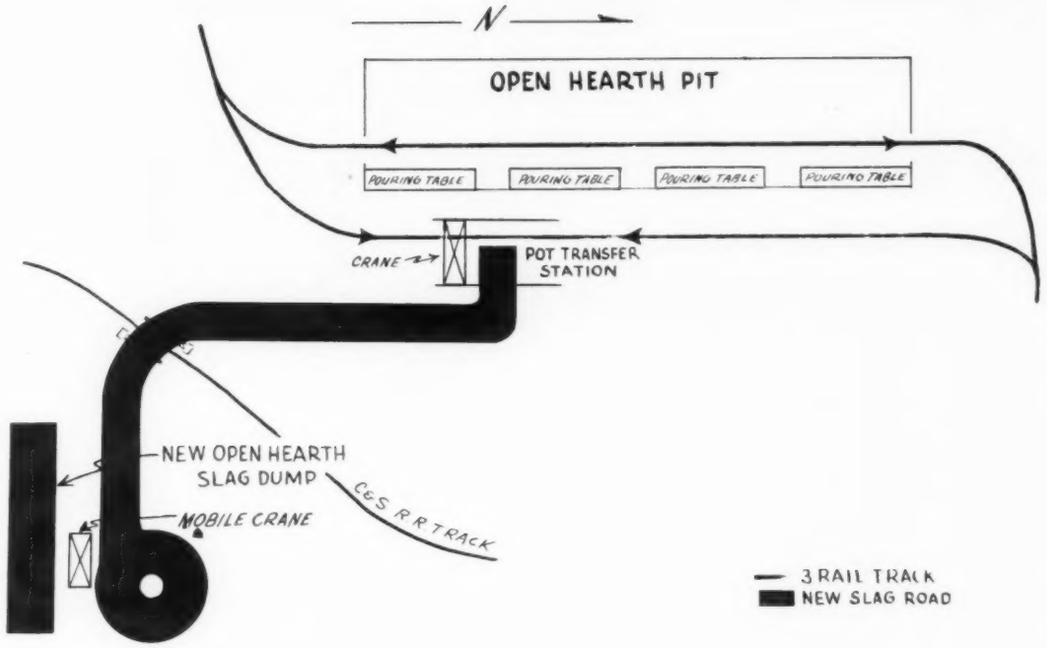


Figure 3 — In an attempt to eliminate the switching bottleneck of the first proposal, a second proposed design was considered which utilized both railroad and mobile equipment.

stands was a limiting factor to the pot size. They are 230-cu ft capacity and are made of cast steel. They are circular in construction, having a flat bottom, so as to remain stable on the trailers. Their height is 6 ft-6 in. with a diameter at the top of 9 ft-10 in. and at the bottom, 6 ft-6 in. To facilitate handling with a spreader bar rigging, four lugs are cast in the top, 90 degrees apart. For dumping, four additional lugs are cast in the bottom.

The pots are cast in the open hearth pit in two operations: first the shell, and then the bottom. One pot will usually hold all of the slag flushed from one heat and the tapping slag which overflows from one ladle. Another pot is required to handle the overflow from the other ladle and the slag poured from the teeming ladle after the heat is teemed. Thus, two pots are now required per heat, where previously five were used.

As a result of increasing the pot size from 100 to 230 cu ft, only about 50 pots are required to be in service, where previously 75 were required; and under maximum furnace operations, only about 70 full pots must be removed from the pit each day, where previously 150 had to be removed. This reduced congestion in the pit, and now less pit crane time is required to handle slag pots, making available more time to set up ladles and teem steel, which are the primary functions of these cranes.

While the pots were being cast, the engineering work was being completed on the transfer station and loading crane, and work was progressing on the slag road. Two tractor units, two trailer units and a dumping crane had been ordered.

During the recent conversion program to double-ladle tapping practice, it was necessary to change the ground level elevation of the pit. Three levels were constructed: the highest one is for the pouring track, which is on the same elevation as the outside terrain; the second level contains the 3-rail track, which is installed in a concrete pad, 15 ft wide, and running the full length of the pit; the third level contains the ladle stands.

While waiting for the equipment to be delivered, experiments were made using an old low-bed trailer-truck unit that had been in the plant for many years. It was found that by installing portable bridges in the pit to eliminate the elevation differential, it was possible to back the truck directly into the pit between the pouring tables, where it could be loaded by the pit crane. From these first experiments, the present method of slag handling was developed, which employs only mobile equipment.

The slag road was then extended, and three truck entrances were provided into the pit, Figure 4. They are perpendicular to the pit, and only the trailer portion of the truck protrudes. Not only did this method eliminate the necessity of the construction of a transfer station, a loading crane, pot cars and railroad tracks, but by entering the pit at 90 degrees, it has reduced the congestion which otherwise would have existed when the pot cars were being switched through the entire length of the pit. This allowed the pit crews to have more area in which to work on their ladles, and the furnace rebuilding crews to operate fork trucks and other materials handling equipment with a minimum of interference. This was important, as the only working area is a 15 ft wide pad, the full length of the pit, 1480 ft.

The trucks are now backed into the pit, loaded by the pit cranes, and driven directly to the new dump where they are unloaded by a mobile crane, dumped and reloaded for transfer back to the pit as required. The tractor-trailer unit used is 73 ft in over-all length, having a turning radius of 60 ft. The tractor is diesel-powered by a 275-hp engine. The trailer is a low-bed type and has a capacity of 100 tons, is 47 ft in length and 10 ft wide. The bed is 24 ft in length and is designed to accommodate two pots. When under full load, the clearance is approximately 10 in. The tires are protected from the heat by steel plates, both fore and aft. Two of these units are used under maximum operating conditions.

After the pots become full at the furnaces, they are allowed to cool until a thin crust is completely over the top to avoid splashing the hot slag. This usually requires about two hours. When the slag has cooled sufficiently to be loaded, the pit crew signals the truck

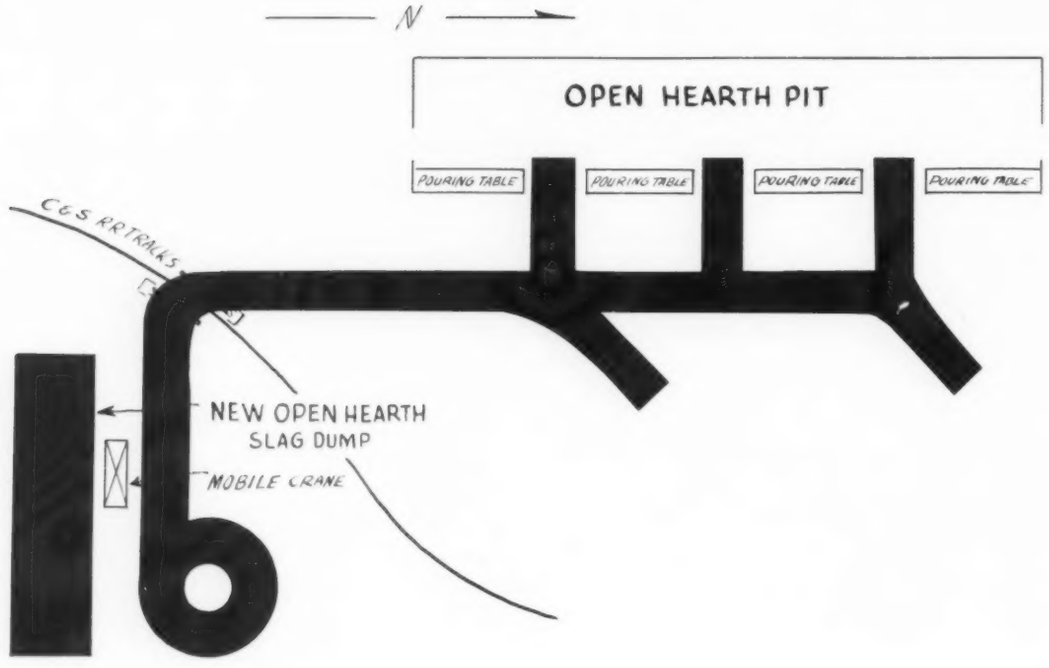


Figure 4 — The method finally decided on used only mobile equipment.

driver to back onto the bridge in the pit. The crane will then unload the empties and place them at the furnaces as required. Two full pots are then loaded for transportation to the dump. A "J"-hook type spreader bar is used to lift the pots. This type bar was selected so that no help from the members of the pit crew would be necessary to hook or unhook the pots.

To handle these heavy loads, a heavy duty road, 30 ft wide and 3100 ft long was constructed from the pit to the dump. This road is used only by the slag trucks for safety purposes and to assure fast handling. Automatic gates and warning lights were installed at the railroad crossing to give ample warning of approaching trains. At the dumping site, the road runs parallel to a long dumping trench, and room is provided so that a 50-ton capacity mobile crane can be operated between the road and the trench. The truck is parked adjacent to the crane, and the full pots are first removed from the trailer and set on the ground. A "J"-hook lifting bar, similar to the ones used by the pit cranes, is used for unloading. Attached to this spreader bar are two long $1\frac{1}{4}$-in. diam cables, with large rings at the ends. These rings are inserted over the lugs on the bottom of the pot. The crane then lifts and dumps the pot into the trench. The dumping trench is approximately 700 ft in length, 50 ft wide and 15 to 20 ft deep. This long length was provided so that as the slag is dumped into the pit, the dumping operation can be moved from one end to the other to allow time for the slag to cool. After both pots are dumped, they are reloaded onto the truck for transfer back to the pit.

This complete cycle, from the pit to the dump and back, requires approximately 15 minutes, and when the open hearth shop is being operated at capacity, approximately 35 to 40 truckloads per day are hauled by this equipment.

All of the operations and equipment on the dumping site are supervised, owned and operated by an outside contractor, who has a contract with the Pueblo plant to recover the metallics from the slag and to dispose of the remaining debris.

The slag is removed from the dumping trench by a drag line and run through a magnetic separator to recover the metallics. The recovered metallics are then trucked back into the plant for recharging at the open hearth or blast furnaces. The discarded refuse material is trucked from the separator and dumped into the low terrain south of the dumping site, so that this land may be reclaimed and made useful.

Available on the dump is a spare dumping crane, which can be placed in operation in approximately four hr, should the present crane require maintenance or otherwise fail to operate. One of the big advantages is that once the low land in the area of the present dump is filled, which will require several years, the dumping site can be moved further south and the road extended. This can be done quickly and at a reasonable cost, whereas had railroad facilities been employed, this would not have been the case.

The handling of open hearth slag by mobile equipment has completely eliminated the bottleneck which had existed for many years, thus helping to make possible maximum furnace operations. By entering the pit at several points, 90 degrees to its length, a completely new concept has been opened up for servicing this side of the open hearth shop. It is now possible, using mobile equipment, to remove rubble and debris and to deliver rebuilding materials to down furnaces much faster and more economically, with less congestion and interference to the pit crews and rebuilding crews. The larger pots have reduced the pit crane time in handling slag, the number of loads into and out of the pit, and have also relieved the congestion in the pit. The operation has reduced labor and maintenance costs and is making possible reclamation of otherwise useless land. A standard gage diesel locomotive has been released from the slag handling service, thus contributing toward more efficient switching service in other departments within the plant. Also, it has made available the old slag yard facilities, which are now being used to store and prepare molds and for maintenance on steel runners and ladles. ▲

Mobile Units Reduce Plant Material Handling Costs

by Dan H. Driscoll,
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. . . . a good inter-departmental, off-track material handling system reduces "no steel" time delays on mills, makes possible utilization of yard space as storage space, and simplifies quick changes of steel grades and sizes when required by short-notice order changes . . . .

THE Pueblo Plant of The Colorado Fuel and Iron Corp. is situated on 588 acres of relatively flat terrain, with adequate additional empty area available for expansion programs. Approximately 25 miles of roadways and 80 miles of standard gage railroad track are available inside the fence.

Materials handling systems during the period of early growth of the plant consisted primarily of the railroad and overhead crane team, supplemented when necessary by strong men and stubborn mules. Consequently, the plant layout in most cases is designed to function around railroad facilities. The mules lost their place in the system during the nationwide conversion of fuel sources from hay to gasoline, and from this transition a trucking section was born.

The trucks were assigned to the same jobs as their 4-legged predecessors. They continued to operate only as occasional supplements to rail transportation, until lessons learned in World War II showed industry the dramatic economies which could be effected by improvements in materials handling techniques. These methods were adopted with outstanding success by individual departments within the plant.

Then, in 1949, a centralized materials handling system had its inception with the installation of a self-loading truck system. This system consists of four trucks equipped with hydraulic self-loading mechanisms and a number of interchangeable steel containers. The containers are spotted as required, transported and dumped by any of the "prime movers." The system contributed greatly toward making possible the very effective housekeeping program in force at Pueblo. In addition, it served as a very versatile tool for many different types of hauling and general lifting jobs. The largest unit currently in use has a capacity of something in excess of 13 tons, with larger units probable in the future.

In 1950, the tractor-trailer concept was added to mobile handling methods, resulting in much more flexibility of off-track operations than was possible with the older "fixed platform" type vehicles. Trailers currently used in this service vary from conventional 15-ton highway type units to specialized "lo-boy" rigs of 50 and 100-ton capacities. One unit is equipped with special "heat pads," which enables it to withstand 1800 F for 15 minutes with a transfer to the trailer frame of only about 300 F. This unit makes possible the trucking of ingots off the stripper to blooming mills soaking pits, if emergency conditions should require this service.

Another very interesting application utilizes 100-ton trailers in transferring open hearth slag pots between the open hearth pit and a slag processing and reclaiming operation. This slag removal job conventionally is assigned to railroad equipment. However, a modernization program, which increased open hearth ingot capacity, made modifications to the pit area mandatory. This, in turn, required a much faster and less costly slag handling system. The mobile equipment solution reduces the man-hours required for slag disposal, eliminates interim storage handlings between the pit and reclaiming operation, and reduces to a minimum the possibility of incurring furnace delays due to lack of available empty slag pots.

BULK HANDLING PROBLEM

Early in 1953, a bulk handling problem involving coal stockpiling, which had been a continuing thorn in the side of operations, was investigated. This problem re-

volved around two particular difficulties, the first of which was the cumbersome and costly stockpiling method in use that required the construction of a broad gage track on top of each stockpile, and the exclusive use of side-dump type railroad cars. A string of 10 to 20 cars was positioned on the stockpile, the doors were dropped, and manual labor used to clean the cars of any remaining material. The track was cribbed and raised as the pile grew. As can be readily seen, this system required a maximum of manual labor, which has become more and more expensive with the years. The second and even more critical point of difficulty lay in the nature of the material. Coal, when stored loosely in the pile, is extremely susceptible to spontaneous combustion, resulting in a very short 3 to 6-months stockpile life.

Since most of the necessary coal mining facilities are within one-day delivery time from Pueblo and are open the year around, stockpiles serve only as emergency facilities. Therefore, a management policy was established which changed the bulk of these stocks from coal to the more stable coke. Only a small stabilized pile of coal was to be maintained as protection for the coke ovens. This pile was constructed by spreading the coal in thin 3 to 6-in. layers with dump trucks and compacting it to a density of 75 lb per cu ft or better, with a rubber tired compactor. Thermocouples were installed at various check points, and, up to this time, four years later, no "hot spots" or other deterioration has developed.

The coke was handled to stock in 30-yard dump trailers. Due to its extreme friability, some difficulty was experienced in transferring the material from the truck to the top of the stockpile, but this was overcome with the construction in our shops of a conveyor type elevating stacker unit. Reclaiming is accomplished with a front-end loader and the dump trailers. The stock material is dumped on the coke wharf, rescreened, and blended with current production to smooth out fluctuations in analysis which might affect blast furnace practice. To date, our breeze loss in the handling operation has been under 10 per cent. Several production surges have utilized coke stocks at tremendous operating savings rather than additional coke oven batteries.

The dump-trailer, front-end loader combination also is utilized in the handling of coke breeze in sinter plant operations. The flexibility of the system has made practical experimental blending work with other materials in sinter production, which now offer many additional cost reduction possibilities.

Tonnages currently handled by the trailers are reaching levels which will soon make feasible a conversion to self-loading, scraper type equipment. This conversion will, in turn, undoubtedly open up many new bulk handling areas for the new mobile equipment.

NEW SEAMLESS MILL

In August, 1953, a new seamless tube mill started producing oil country tubular products at CF&I's Pueblo plant. As higher production levels were attained, it became obvious that billet storage capacity considerably in excess of that available under crane runways in the mill building itself would be necessary to prevent excessive "no steel" delays. Extensions to the existing billet yard and crane runway were impractical from both layout and cost standpoints. Outside storage was attempted under a gantry type crane, but costs were prohibitive. Further, the maintaining of steel identities was nearly impossible.

The possibility of using straddle type lumber carriers was next investigated. They seemed to be ideally suited to the needs of the operation. Adequate open area was available adjacent to the seamless mill billet yard, which could serve as a storage area. The rolling mill producing the billets was readily accessible to mobile equipment, so that transfer between railroad and straddle carrier was unnecessary. Lastly, a machine was commercially available which could handle a 25-ton unit-load, and could theoretically move enough of these units to compete favorably with the railroad on a cost-per-ton basis.

One of these straddle carriers was purchased. A policy was set to add the unit to the plant-wide materials handling section rather than considering it departmental equipment. This policy has made possible all subsequent savings and advancements in the system by insuring flexibility and equipment availability wherever and whenever it was needed.

Specifications of the straddle carrier selected include, in addition to a 50,000-lb capacity, a wheelbase of 162 in., a package or unit-load size of 64 x 66 in., and an over-all height of 146 in. The turning radius empty is approximately 26 ft. This, of course, increases with added load length. All machines currently are powered with gasoline engines. These were selected in preference to diesel power on the basis of somewhat easier maintenance and considerably easier driver training.

Since control of handling equipment was placed outside the operating department, it was immediately necessary to establish rapid communication facilities between operating demands and handling department supplies. A communications system, based on mobile 2-way radio combined with a general policy framework covering inventory controls, was established, which has resulted in an efficient control system. This policy generally established that the materials handling section would be responsible for maintaining locations of material unit-loads without detailed inventories as to the contents of the unit-load. The latter would be maintained by the operating department and keyed to a single bolster number for identification and delivery purposes.

The actual steps in the system now operating can be broken down as follows:

1. Request for materials handling service is telephoned to the trucking dispatcher.
2. Dispatcher records order as to nature of the order and time received on a work sheet.
3. Either immediately, or when a unit radios in its availability, the dispatcher assigns the job to a carrier and records this fact and the time assigned on the particular unit's vehicle log, Figure 1.
4. Upon completion of the assignment, the vehicle operator reports by radio for reassignment, and the dispatcher records the finish time on the vehicle log.

The listed steps follow conventional dispatching procedures and furnish excellent control of vehicle availability of straddle carriers as well as other radio equipped mobile equipment. The dispatcher has a choice of which type vehicle to assign to any particular

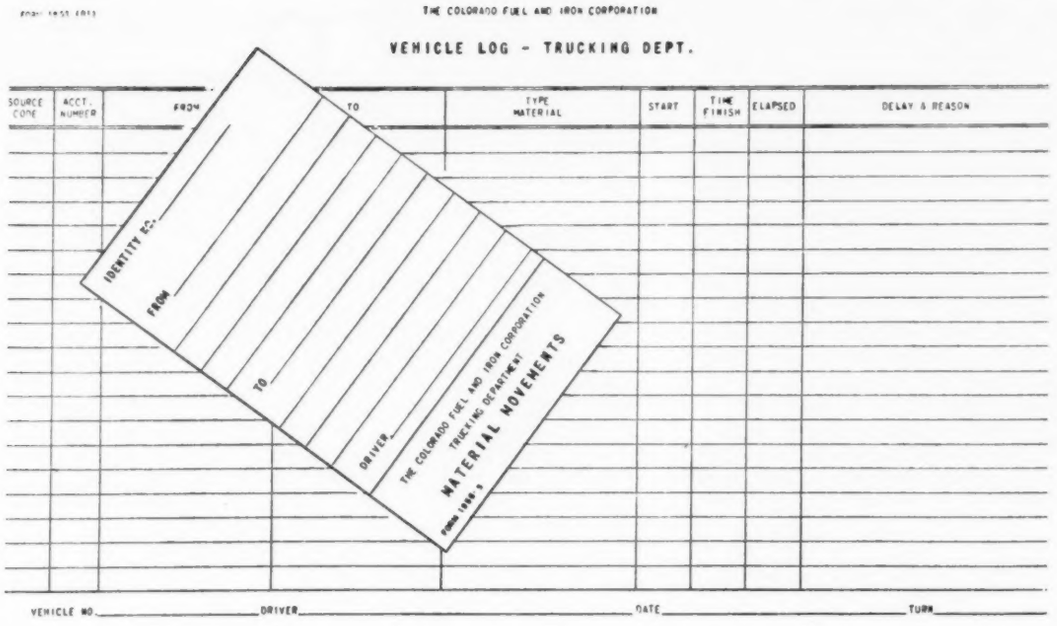

Figure 1 — The assigning of carriers by the dispatcher is recorded on this log, and each carrier fills out a material movements card each time a loaded bolster is moved.

job, with a wide range of equipment interchangeability increasing the effectiveness of the entire system.

However, particularly with straddle carrier movements, the fact that a loaded bolster may be moved several times prior to final disposition made necessary an additional record as to location of the steel at all times. This data was obtained very simply. Each carrier operator has "materials movement" tickets, Figure 1, which he is required to fill out each time a loaded bolster is moved. The information on the ticket includes the identity number of the steel, which is assigned at the point of loading, the location of the pick-up point, the location of the disposition point and the driver's name. These tickets are forwarded three times per turn to the dispatcher's office, where a numerical file is kept, with current locators replacing obsolete tickets. For example, on October 16, 1957, the bolster load of steel under identity number 10–416 made the following moves:

7:30 A.M. Bolster loaded at rail mill and assigned No. 10-416. Carrier service requested.

7:35 A.M. Carrier picked up load and set it in "J" area, No. 29 stall. Operator filled in ticket 10–416 from rail mill to J-29.

9:00 A.M. Materials movements tickets were forwarded to dispatcher and placed in file.

1:00 P.M. Bolster moved from temporary storage in "J" area to permanent storage in "G" area. Operator filled in ticket 10–416 from J-29 to G-34.

2:30 P.M. Materials movement ticket forwarded to dispatcher and filed in place of the previous location.

8:30 P.M. Material was ordered into the mill. Operator filled in ticket 10–416 from G-34 to billet yard.

10:00 P.M. Ticket forwarded to dispatcher, where previous ticket was removed from file, and since material had moved into production as shown by "billet yard" entry, both tickets were destroyed.

The system outlined, in addition to furnishing locations, also furnishes a count of loaded bolsters. Too, by changing colors of the tickets every 30 days, slow moving material, which should be unloaded and stacked to conserve stocking areas, is easily pinpointed. This system is augmented, as seems to be necessary with any perpetual inventory system, with periodical physical verifications.

As a result of the outstanding success of the straddle carriers at the seamless tube mill in both cost reduction and delivery convenience, other operating departments began requesting methods evaluations for possible applications of carrier service. As a result of these requests, a fleet of eight carriers is currently in service, handling in excess of 200,000 tons per month of in-process and finished material.

This tonnage, consisting of material varying from $^{3}/_{8}$-in. diam rebar in 60-ft lengths to units made up of 5-ton ingots, is handled on four basic bolster types.

The 2-piece billet bolster, Figure 2, is the backbone of the service and handles a greater tonnage than all the other designs combined. Of necessity, due to the number of units involved, this bolster had to be designed around the requirements of minimum construction cost, coupled with ruggedness and simplicity of repair. The design finally selected has been maintained to date as very nearly an ideal compromise of these factors. It consists of a top section of 6-in. H-Beam, 66 in. long, bolted to a bottom section of 6-in. H-Beam, 54 in. long. Two pieces of heavy 6 x 4-in. angle bolted to the upper section serve as material stops. Damage to this bolster usually consists of failure of the web of the lower beam through impact caused by magnetic loading and unloading. The remainder of the bolster is easily salvaged, however, by unbolting and replacing the damaged section. This bolster is used for transporting and storing ingots for our blooming mills, tube round for the seamless tube mill, square billets for the rod mill, and miscellaneous steel sections up to about 18 ft in length.

The second bolster design, Figure 3, is for handling casing and tubing from the seamless tube mill and a few other selected pipe and bar items throughout the plant, where the package must be controlled more closely than is possible with the billet bolster. The pipe bolster, although rather specialized, has made possible extensive

Figure 2 — This 2-piece bolster is used for transporting and storing ingots for the blooming mills, tube rounds for the seamless tube mill, square billets for the rod mill, etc.

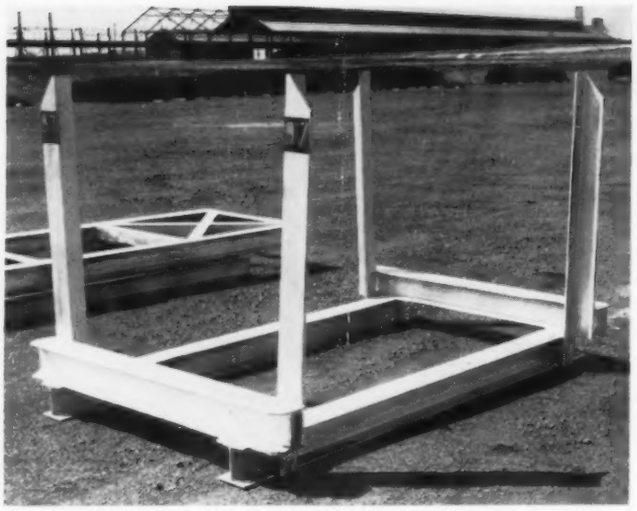

Figure 3 — This bolster design provides better control of the pay load than the one in Figure 2.

improvements of seamless tube mill production rates without the necessity of providing costly increased surge capacity within the mill.

STRETCH MILL ADDED

For example, recently a stretch mill was added to hot mill facilities, which tremendously increased the production of seamless tubing in $2\frac{3}{8}$ to $4\frac{1}{2}$ in. OD. In fact, the increase was considerably above finishing capacity; therefore, the surge tonnage was merely loaded on the pipe bolsters, moved by carrier to inexpensive outside storage, and brought in to be finished as required. Other sizes in various stages of completion are moved on these bolsters as conditions warrant to insure efficient stockkeeping practices within the mill.

The third bolster, Figure 4, was designed to furnish 20 ft of longitudinal strength to either flexible material or product which might be damaged through bending. It is used to handle material such as grader blade strip at relatively high temperatures, bundles of bolts and ball rounds in lengths up to 30 ft, and merchant and structural materials in 30 ft or shorter lengths.

The fourth bolster, Figure 5, serves the same pupose as the previous one except for its additional length. The over-all bolster length of 50 ft serves as a rigid backing for all material up to 60 ft in length. This bolster is loaded with 20 to 25 tons of 60 ft flexible material such as light angles. Some difficulty with long lengths was experienced at first due to an uncontrollable oscillation started by the slightest carrier bounce. This was brought under control, however, by doubling up on shock absorbers on the carriers, which effectively dampened the reaction.

A current plant improvement added a double cooling bed at the rod mill to make possible the rolling of light bar sections, specifically No. 3, 4 and 5 rebar, on the mill in addition to the former coiled rod production. However, this bed was economically feasible only if handling methods could be developed which would utilize existing warehouse facilities and would not require installation of expensive railroad facilities. A modification of the fourth bolster, Figure 6, is designed to handle 60 ft or shorter rebar under these specialized conditions.

Figure 4 — Designed to furnish longitudinal strength for its pay load, this bolster is used to handle material such as grader blade strip.

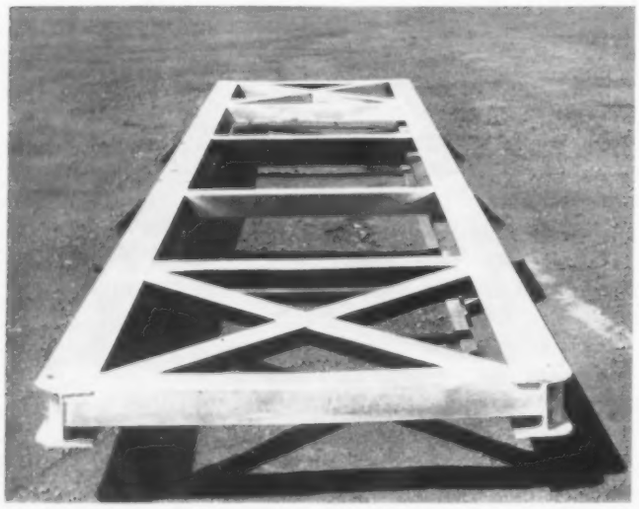

Figure 5 — This bolster, designed for the same purpose as the one in Figure 4, can accommodate longer lengths, up to 60 ft.

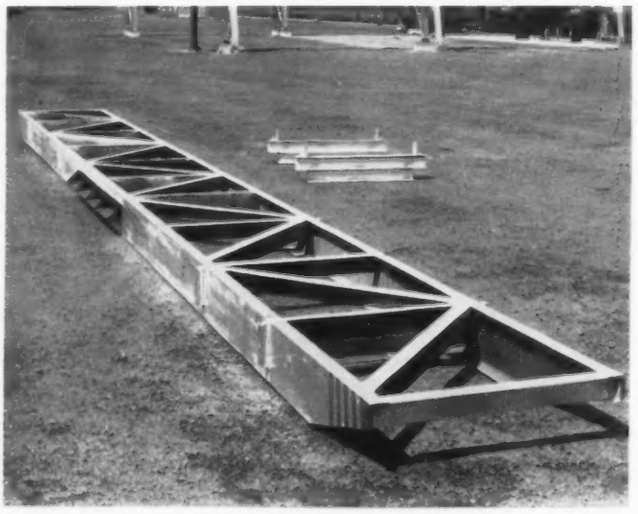

Figure 6 — A modification of the bolster in Figure 5, this bolster is designed to handle 60 ft or shorter rebar under specialized conditions.

The finished rebar is strapped in standard 5000-lb bundles after being sheared to length, then loaded on the bolster to a maximum of eight bundles per bolster. The superstructure furnishes adequate ground clearance for the overhang of 60-ft material during the transfer by carrier to the merchant products warehouse where they are unloaded, and the material stocked or shipped by means of a conventional overhead type crane.

With the types of bolsters indicated, and adequate stocking area available, the straddle carriers' capacity and potential seemed unlimited. But, as the tonnage handled and the product mix increased, problems involving storage areas and bolster cost grew more urgent.

For example, the bolster used for handling rebar is relatively costly and was designed for transportation only. Yet conditions arose which made outside storage of a considerable tonnage of rebar essential. Therefore, it became necessary to stock these items. This was accomplished by equipping a 10-ton fork lift truck with a 45-ft walking beam to transfer the rebar from bolster to stockpile and later back to the bolster for shipment. The use of these fork trucks in combination with the straddle carriers holds down bolster investment cost, increases storage capacity, and generally provides maximum flexibility in the field of fast, low cost yard handling.

PREVENTIVE MAINTENANCE PROGRAM

All repair service and preventive maintenance on mobile equipment is the responsibility of the garage section, except for radio repair, which is contracted at this time. A cost record system is in effect which furnishes monthly operating and maintenance charges against each vehicle. These charges are utilized as a basis for a controlled replacement program as well as for standards to judge maintenance effectiveness.

The value of an effective preventive maintenance program can never be overestimated in work of this nature. In the rush and pressure of operations, preventive maintenance is probably the item most vulnerable to the sin of omission. However, an accumulation of these minor maintenance defections will inevitably seriously cripple the operation, as can be easily visualized by a close look at the duties of materials handling equipment. For example, a passenger automobile will average about 10,000 miles per year, while handling equipment travels an equivalent 120,000 miles. Also, the stop-and-start nature of a materials handling operation compared to modern turnpike cruising further widens the maintenance gap.

To secure preventive maintenance, all units are equipped with hour meters, from which planned periodic inspections are made and recorded. These inspections are made possible by a management policy which authorizes the removal of units from service as necessary to perform the inspection. The final requirement of the program is a well trained, capably supervised maintenance staff, who understand and can assume the responsibilities involved in their job.

Favorable cost comparisons with other similar operations witness the current success of the maintenance program and encourage supervisory efforts to constantly improve practice along these lines.

SUMMARY

Progress to date in materials handling methods has been almost unbelievably fast. Still, there are new challenges arising daily. A recent development involved the expansion of finished seamless product stocks, again beyond the capacity of warehouse facilities. Outside storage of the surge stock by means of the straddle carrier-fork truck team was selected as a satisfactory solution. In fact, the solution was so satisfactory that the material stored and shipped from this outside storage area has grown from a few miscellaneous odds and ends to nearly 75 per cent of the total stock of finished seamless goods.

The development of straddle carrier and other off-track handling equipment offers so much greater selectivity and convenience of steel deliveries to operating departments than was ever considered feasible with conventional methods that some marginal jobs have been assumed on this basis alone. Changes in steel grades and sizes to meet changing order requirements on short notice are relatively easy, and "no steel" delays on mills serviced by this equipment have nearly completely disappeared.

However, as was originally stated, CF&I's plant layout was keyed to rail transportation in most cases, and railroad systems offer certain very desirable cost characteristics on large tonnage movements. Therefore, current planning is directed toward an integrated handling system which will combine the huge railroad unit-load for economical transportation to stock with a fast, easy breakdown method into the smaller off-track unit-load for selective delivery to operating departments. Progress in this field, in addition to offering all the advantages of flexible handling already mentioned, will also reduce railroad operating costs considerably by reducing car detention times, actually from a period of days to a potential matter of hours.

Progress in improving plant-wide materials handling ability to date has been accelerated by imaginative and intelligent establishment of general operating policies. The remaining steps of consolidation and controls must and will inevitably follow under the same combined pressures of supervisory enthusiasm and the competitive requirements of minimum production costs. ▲

The Direct Reading Spectrograph And Its Use

by William J. Fertal,
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. . . . use of the fast, direct reader spectrograph quickly provides the required information for diagnosing needs for metallurgical additions

THE increased demand for metal products in the past few years has resulted in the development of machines and processes which greatly increased the producing capacity of individuals. Stringent specifications for a great variety of steel products created a need for fast, accurate control of steel grades from the bath to the finished product. Rapid chemical analysis of the steel, therefore, became necessary for steel production to keep pace with steel processing. The direct reader spectrograph provides the answer for fast chemical analysis.

Spectrography is the study and measurement of the spectrum, which is the ordered arrangement of radiation according to its wave length.

Every element can be made to emit light when subjected to suitable excitation, and each elemental light has its own characteristic wave length which leads to its positive identification. The light emitted from a compound is composed of all the wave lengths of each element present. It is necessary, therefore, first to excite all the elements to force light emission and then to separate the emitted light into the components for identification. For example, if heat is applied to a steel

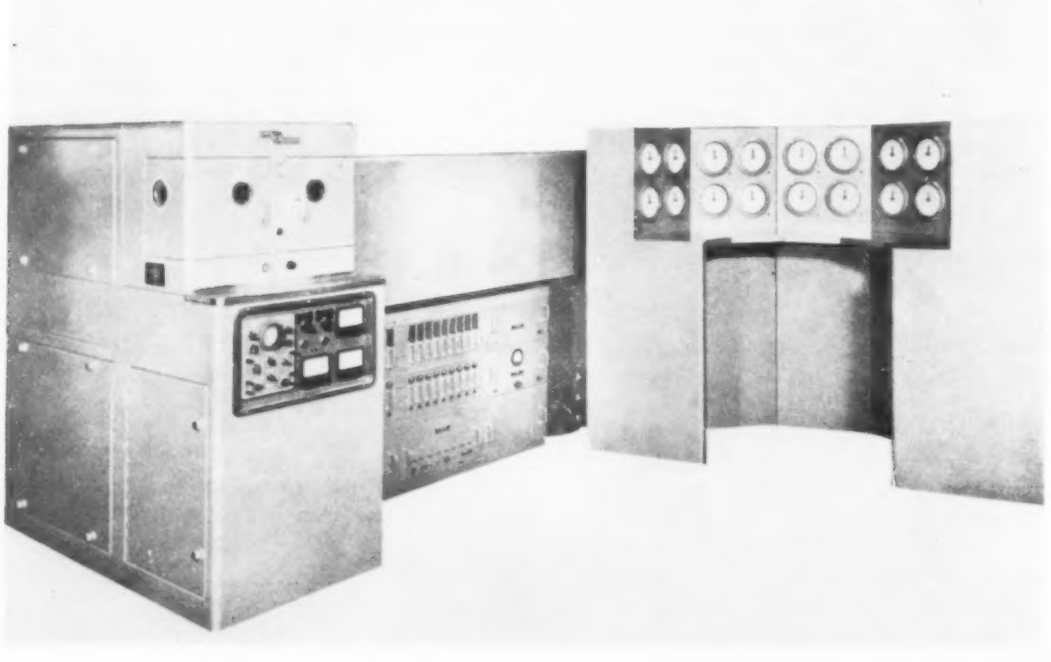


Figure 1 — The direct reader is located in a windowless, air-conditioned room.

bar, it absorbs energy and gives off heat. Further application of heat causes a color change from a dull glow, through red in various shades, to white. Now both light and heat are radiated. Still further application of heat results in a molten state, and observation of this state will disclose a boiling action as some of the particles are vaporized.

A brief description of the direct reader used in the Pueblo plant of The Colorado Fuel and Iron Corp. is in order. The instrument is located in a windowless room, 18 x 20 ft which is air-conditioned to maintain temperature at 75 F, plus or minus 2 F, and relative humidity not to exceed 45 per cent. These requirements are necessary because of the extreme sensitivity of the instrument to temperature and humidity changes. The direct reader consists of a source unit, arc-spark stand optics, electronic system and recording console unit, Figure 1. It stands 5½ ft high, is 3 ft-2 in. wide and 12 ft long and weighs 8300 lb. The recording console is an assembly of four panels, each having four recorder clocks. The unit at CF&I's Pueblo plant has a total of 16 clocks. The floor on which it stands is an 8-in. reinforced concrete slab to accommodate the concentration of weight.

The spectrograph is an instrument designed to resolve the combined spectrum, produced by the radiation of an excited sample, into the individual components and record them for identification and quantitative measurements, Figure 2. The sample is excited in an arc-spark chamber by the application of high voltage (about 5000 volts) in the direct reader. The emitted light is directed through entrance slit to a reflecting mirror which directs the light to a reflecting diffraction grating for dispersion. In the photographic spectrograph, the incident light emerges from the diffraction grating separated into its individual components of radiation and is reflected onto a photographic plate which records the resolved spectrum. The photographic plate is located on the focal curve which is part of the Rowland Circle. After development of the film, the spectrum appears as blackened lines on the plate. The lines are then identified to determine the constituents of interest; the line intensities are measured and compared with standards to yield a quantitative result. A skilled spectrographer can arrive at an analysis, using the photographic spectrograph, in 30 to 40 minutes. In contrast, however, the direct reader spectrograph, referred to as the D. R., can provide the percentage composition of as many as 18 elements from a prepared sample in less than three minutes without requiring a skilled chemist. When a greater number of elements are required or extremely wide ranges of concentration are encountered, special switching circuits are used. Going back to the sample for a moment, since its preparation is critical, a perfectly plane surface free from blowholes, pits or inclusions must be used. At the same time, however, the preparation must consume very little time. A high-speed cut-off wheel is used which develops 2500 rpm and cuts through a 1 3/16 in. thickness of steel sample in 4 to 5 seconds. A brief period of cooling is followed by use of a side-grinding wheel to eliminate sharp edges and burrs. A final polishing is performed on a belt sander of 80-grit size. The over-all preparation is accomplished in approximately 2 to 3 minutes.

The Pueblo plant of The Colorado Fuel and Iron

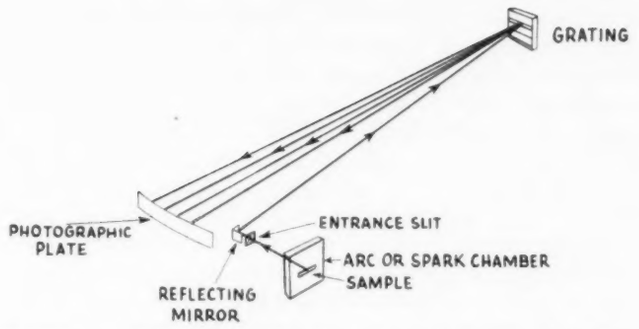


Figure 2 — This schematic illustrates the operation of a photographic spectrograph.

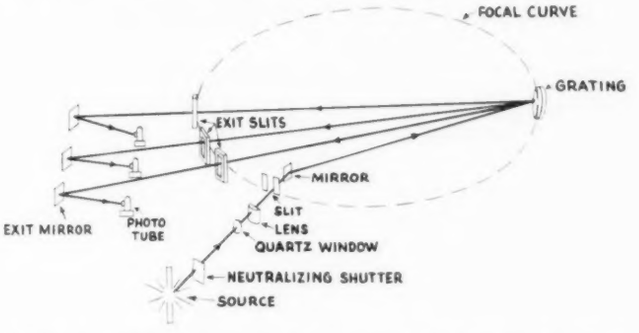


Figure 3 — This schematic illustrates the operation of a direct reader type spectrograph.

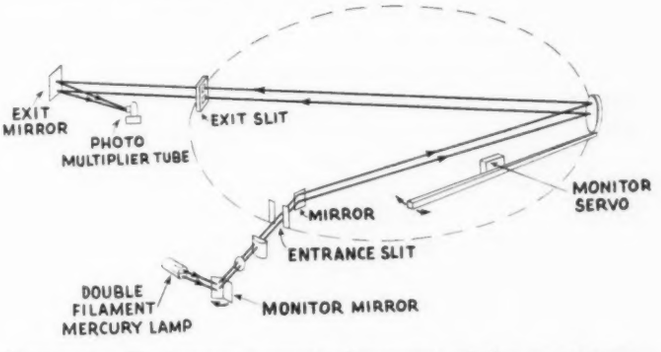


Figure 4 — To insure correct alinement of the spectrum lines through their respective slits, a servo shown here, maintains it by monitoring the position of a mercury spectrum line.

Corp. has both types of spectrographs. Each direct reader is custom tailored by the manufacturer, to the requirements of each purchaser for providing rapid analysis of a routine repetitive nature. In the steel industry, for example, iron is used as the internal standard, and elements such as manganese, phosphorus, silicon, copper, nickel, chromium, molybdenum, vanadium, aluminum and tin are set up on the D. R. to provide a direct readout of each element as compared to the standard. In the aluminum industry, aluminum is used as the standard; thus standards and elemental channels vary in each industry according to need.

At the Pueblo plant, the analytical problem requires the rapid analysis of hot metal, pig iron, blast furnace slag, steel and slag while in the open hearth furnaces and steel as it is teemed into ingot molds. The D. R. in this plant, therefore, was tailored to provide a direct readout of the aforementioned elements as well as various oxides.

The D. R. uses a combination of optical and electronic devices. As in the photographic type, the pre-

pared sample is subjected to a high voltage in the arc-spark chamber. This causes actual burning of the sample at the surface, and particles of the burning sample are vaporized into the arc. In vaporizing, these particles radiate heat and light.

The emitted light passes through the entrance slit onto the entrance mirror, from which it is reflected to the diffraction grating. The diffraction grating functions much like a prism. A white light directed onto a prism will emerge in the familiar rainbow spectrum with the colors arranged in the order of red, orange, yellow, green, blue and violet. A similar effect will be observed if the light is directed onto a reflecting surface ruled with closely spaced parallel lines. The reflecting diffraction grating used in this D. R. has 30,000 lines per in., ruled on a concave mirror.

About 1870 Professor Rowland at Johns Hopkins University found that if an entrance slit were placed anywhere on a circle drawn tangent to a diffraction grating and based on the curvature of the grating, the resulting spectrum would be in focus anywhere on this circle. This focal curve thus became known as the Rowland Circle, Figure 3.

An exit slit for each element to be analyzed is placed on the segment of the Rowland Circle. The position of each slit is predicted mathematically using optical laws. Each elemental beam passes through its exit slit and is reflected from an exit mirror onto a photo-multiplier tube. The output of the photo-multiplier tube converts the light energy into electrical energy. Since the intensity of the light is a function of the quantity of the element present in the sample, the electrical energy stored in the capacitor associated with each element will preserve this relationship.

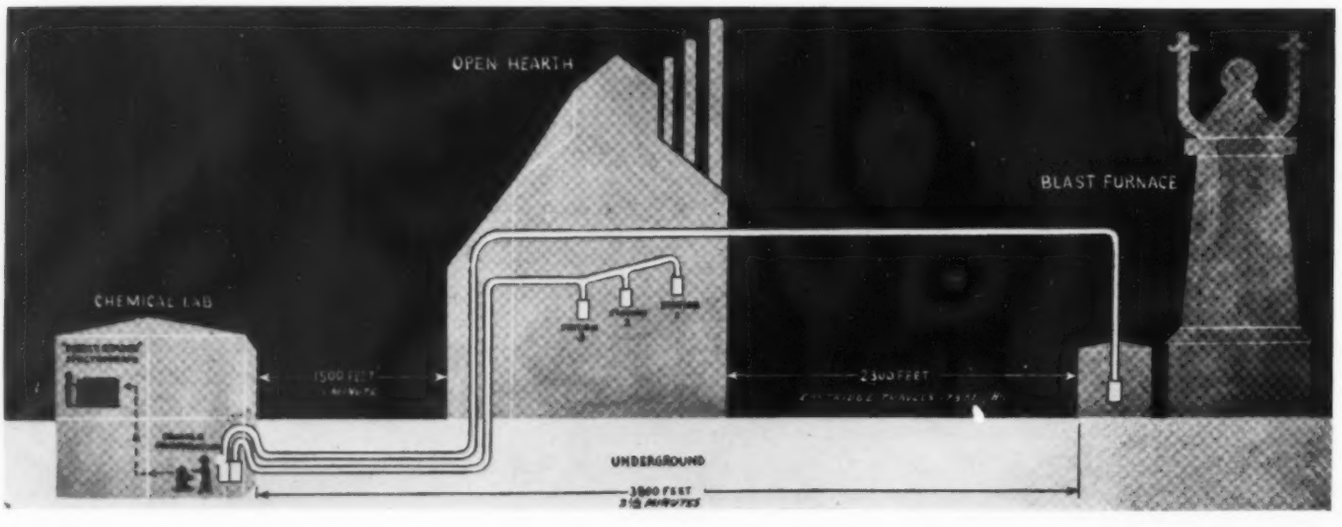
The analysis required is desired in percentage composition and thus needs to be compared to a standard. The standard used in this case is iron. Simultaneously with charging capacitors for each element being analyzed, a reference capacitor is charged from the iron spectrum line.

To insure correct alinement of the spectrum lines through their respective slits, a servo monitors the position of a mercury spectrum line and corrects to maintain alinement. This is accomplished by using a dual filament mercury lamp and dual exit slits. Each alternate half cycle of the a-c supply lights first the top and then the bottom of the mercury lamp filament. A blocking bar is positioned in such way as to separate the filament into two separate sources. If misalinement should occur, the pulses associated with each filament will differ in amplitude when received through the exit slits by the photo-multiplier tube. The unbalanced voltages developed by the photo-multiplier tube then cause the servo motor to operate, driving the diffraction grating mount until balanced voltages again exist. The direction of drive depends on which half cycle has the largest amplitude, Figure 4.

Upon completion of the exposure cycle, the program control switches to the measure cycle. In this period, the standard capacitor is discharged through a resistance and compared to the charge existing on each of the capacitors associated with each element being analyzed. The necessary switching is accomplished by relays placed into operation by the program control chassis. A clock associated with each element starts running at the start of the measure cycle. As the voltage on the standard capacitor which is being discharged equals the voltage on any of the elemental capacitors, its clock stops. Thus the clock for an element runs from the time the measure cycle starts until the standard capacitor voltage which is undergoing a controlled discharge equals the charge on the element's associated capacitor. Since the discharging of a capacitor through a resistance is governed by strict mathematical law, the residual voltage at any time (t) can be expressed as a percentage of the original charge; therefore, with a knowledge of the time taken for the standard capacitor to discharge down to the charge of each of the elemental capacitors, the quantity of that element present in the sample expressed as a percentage based on the iron standard is readily obtained either from tables, calibration curves or clock dials calibrated logarithmically to give direct percentage readings.

It has been shown that the D. R. is fast and provides the industry with many advantages even though it is normally restricted in application to the number and type of constituents for which it was designed. One of the chief advantages of this rapid analytical instrument

Figure 5 — In order to take advantage of speed of the direct reader spectrograph, two reversible pneumatic tube systems were installed to quickly transport samples to the chemical laboratory.



is that needed information is supplied on a timely basis so that proper adjustments can be made. For example, the D. R. provides fast information on blast furnace slags for silica and the oxides of aluminum, calcium, manganese, magnesium and iron. Necessary corrections are thus made quickly in the blast furnace department. Next, the open hearth department is given the analysis of the hot metal before it is poured into a furnace and is able to add the necessary ingredients to the bath to produce the desired grade of steel.

Rapid determination of constituents in the steel bath offers a quantitative means of determining finite additions necessary for a specified grade and the optimum time for the addition. The timely addition of constituents results in shorter tap-to-tap time per furnace, resulting in increased steel production. Addition of only the proper quantities of materials also produces savings in materials.

The analysis of ladle samples taken when steel is teemed from the ladle to the mold offers fast, proper, final grading and quick application of the ingots to the proper mills. This results in reduced fuel costs as a shorter track time reduces heat loss, and proper rolling temperatures are reached in the soaking pits in a shorter time.

In order to keep pace with the extremely rapid analytical technique which the direct reader offers, it was necessary to develop a rapid means of delivery of samples and reports of analysis. Thus, two reversible pneumatic tube systems were installed, one serving the blast furnace 3800 ft from the laboratory, the other serving the open hearth approximately 800 ft away. Samples are received from the blast furnace in approximately two minutes and from the open hearth in less than one minute. Similarly, the written report of the analysis is transmitted back to the open hearth and blast furnace as soon as the determination has been made, Figure 5.

In addition, the cost of making analyses is reduced first by using semi-skilled operators, and second by reductions in force. Although the two spectrographs at Pueblo plant, Colorado Fuel and Iron Corp., could have been housed in either the former facilities modified or in additions thereto, it was recognized that the considerable savings in manpower and additional analyses provided could more than adequately pay for completely new chemical laboratory facilities better located with respect to the open hearth which is the principal user of the analytical service. This premise was borne out in fact. In the first three months of spectrographic operation, January, February and March of 1958, approximately 33 per cent of the initial cost was applied toward pay-off. Not only has there been a reduction in cost per analytical unit from $0.323 per unit to $0.120 per unit, but many more analyses have been made. For example, tin analysis was formerly a time-consuming determination requiring 3 to 4 hr and the services of highly skilled chemists. This is now done on the spectrograph in 2 to 3 minutes. A similar situation exists with respect to the other elements to be determined.

At the Pueblo plant, the photographic spectrograph is used to identify and determine quantitatively trace constituents in ores and minerals, for acceptance inspection of ferrous and nonferrous metals, for wear evaluation of diesel engines, and quantitative analysis of constituents in iron and steel other than those determined on the direct reader.

In conclusion, it may be said that the use of both the direct reader and the photographic spectrograph provides the Pueblo plant of The Colorado Fuel and Iron Corp. adequate facilities for rapid routine analyses on a timely basis and for investigation of problems of nonroutine, research or development nature. ▲

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1959 AISE ANNUAL CONVENTION—

◀ President Emil Kern officially opened the convention at the Business Meeting, Monday, September 28. Despite strike conditions a total of 2477 registrants attended the three-day meeting.

▶ Authors and chairmen met each morning for breakfast and briefing. Shown are Electrical Session members (left to right): R. J. Byrnes, Marshall Brittain, R. J. Beeswy, J. R. Erbe, H. G. Frostick, E. R. McGaughey, H. H. Angel and J. A. Drgon.

◀ Lubrication panel members shown here are: Left to right, C. T. Lewis, N. A. Bracht, J. R. McCoy, G. S. Hudson, L. H. Gillespie and W. G. Ritter.

▲ Chairmen of the Rolling Mill Session D. C. Horsman and R. P. Schuler (seated left) give some pointers to their authors. Seated are C. H. Roberts and T. M. Kilgo, standing are H. S. Orr, F. R. Romeo and A. A. Bradd.

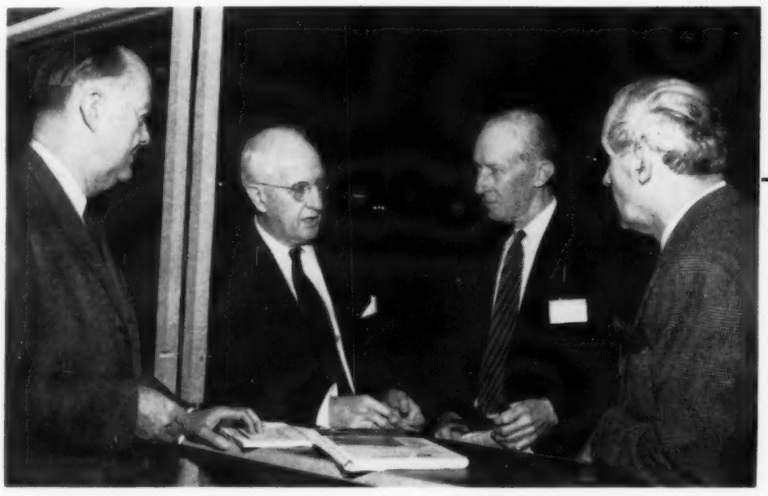
◀ Operating practice session chairmen C. A. Roberts, Jr. and W. O. Bishop (standing) outline procedures for authors C. D. Wright, Louis Xidis and G. E. Reid.

PICTORIAL REVIEW

HOTEL SHERMAN • CHICAGO, ILL.

SEPTEMBER 28, 29, 30

▲Typical of the interest shown in the various papers is this group attending the Electrical Session for the paper "The Blooming Mill Programmed."



◀T. J. Ess, AISE Managing Director, chats with E. C. Smith, chief metallurgist, Republic Steel Corp., J. L. Young, vice president, U. S. Steel Corp. and W. F. Cartwright, assistant managing director of the Steel Co. of Wales, Ltd.

▲ This registrant seems a bit disappointed as he learns that the scheduled trip to Inland Steel Co. has been cancelled. Strike conditions necessitated the cancellation which cut the meeting schedule to three days.

▲ Reception for the speakers' table guests preceded the annual banquet. Among those present were G. T. Avery, president, Acme Steel, C. J. Hunter, general superintendent, South Works, U. S. Steel, F. M. Rich, vice president—steel manufacturing, Inland Steel, E. C. Logelin, vice president, U. S. Steel, T. W. Hunter, general superintendent, Gary Steel Works, U. S. Steel, and T. J. Koenig, general superintendent, Gary Sheet and Tin Mill, U. S. Steel.

▼ View shows the speakers' table and a portion of the 824 persons attending the banquet.

CURRENT AISE DISTRICT SECTION MEETING NOTICES

BIRMINGHAM SECTION

Monday, November 30, 1959—Social Hour 6:30 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"Design and Operating Features of U. S. Pipe and Foundry Company's No. 5 Blast Furnace," by Daniel E. Watkins, General Superintendent of Blast Furnace and Coke Ovens, U. S. Pipe and Foundry Company, Birmingham, Ala.

Thomas Jefferson Hotel, Birmingham, Ala.

BUFFALO SECTION

Tuesday, November 10, 1959—Inspection Trip 4:00 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

Inspection Trip: Dunkirk Works, Allegheny Ludlum Steel Corp., Dunkirk, N. Y. (Postponed from October Meeting.)

"Processing of Tool Steels," by W. H. Love, Chief Works Metallurgist, Dunkirk Works, Allegheny Ludlum Steel Corp., Dunkirk, N. Y.

Dinner and Meeting, Shorewood Country Club, Dunkirk, N. Y.

CANTON SECTION

Monday, November 16, 1959—Dinner 6:30 P.M.
Plant Visitation follows dinner
Inspection Trip: Forging Plant, Ford Motor Co., Canton, Ohio
Dinner served at Plant Cafeteria

CHICAGO SECTION

Tuesday, November 3, 1959—Dinner 6:15 P.M., Meeting 7:45 P.M.

"Economics of Steelmaking," by William T. Hogan, S.J., Professor of Economics and Director, Economics Program, Fordham University, New York, N. Y.

South Shore Country Club, Chicago, Ill.

CLEVELAND SECTION

Tuesday, November 24, 1959—Social Hour—6:00 P.M., Dinner 6:30 P.M., Meeting 7:45 P.M.

"Progress Toward Complete Automation of Blast Furnaces," by Dr. Melvin J. Greaves, Chief Engineer, Metals Div., Arthur G. McKee & Co., Cleveland, Ohio

"Iron Ore Agglomeration—Sintering and Pelletizing," by Allen English, Staff Engineer, Metals Div., Arthur G. McKee & Co., Cleveland, Ohio

Cleveland Engineering and Scientific Center, 3100 Chester Avenue, Cleveland, Ohio

COLORADO SECTION

Tuesday, November 17, 1959—Social Hour 6:30 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"Computer Applications at The Pueblo Plant, The Colorado Fuel and Iron Corp.," by W. R. Dunn, Division Controller, Western Div., The Colorado Fuel and Iron Corp., Pueblo, Colo.

Minnequa University Club, Pueblo, Colo.

DETROIT SECTION

Tuesday, November 10, 1959—Dinner 6:30 P.M., Meeting 8:00 P.M.

"Pneumatic and Hydraulic Material Handling Systems in the Steel Industry"

"Recent Developments in All-Basic-Open-Hearth-Furnaces; Use of Oxygen Roof Jets, Etc."

"Combustion Developments—Annealing Furnaces"

Parlors E, F and G., Engineering Society of Detroit, Detroit, Mich.

LOS ANGELES SECTION

Details not available.

PHILADELPHIA SECTION

Saturday, November 7, 1959—Dinner 6:00 P.M., Meeting 7:00 P.M.

"New Approach to Centralized Utility Dispatching at Fairless Works," by F. W. Allen, General Foreman Utilities Dispatching and Electrical Operations, and L. Cizmadia, Fuel Engineer—Utilities, Fairless Works, United States Steel Corp., Fairless Hills, Pa.

"Development of a Heavy Machine Tool Program," by F. J. Wolfe, Assistant Superintendent No. 2 Machine Shop, Manufacturing Div., Bethlehem Steel Co., Bethlehem, Pa.

Engineers' Club, 1317 Spruce Street, Philadelphia, Pa.

PITTSBURGH SECTION

Monday, November 9, 1959—Social Hour, 6:00 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"Oxygen and Steelmaking Processes—Comparison of Open Hearth, LD, Kaldo, and Rotor Processes," by E. F. Kurzinski, Manager, Applied Research & Development, Air Products, Inc., Allentown, Pa.

Alumni Room, University Club, University Place, Pittsburgh, Pa.

ST. LOUIS SECTION

Wednesday, November 18, 1959—Social Hour 6:00 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"Application of Permanent Magnets in Industry," by William J. Faller, Application Engineer, Eriez Manufacturing Co., Erie, Pa.

Elks Club, Granite City, Ill.

SAN FRANCISCO SECTION

Tuesday, November 17, 1959—Social Hour 6:00 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

Pacific States Steel Corp. Night

"New Concept in Electrical Systems Control of Steel Industry Processes," by E. H. Browning, Manager, Metal Working Section, Industry Engineering Dept., Westinghouse Electric Corp., East Pittsburgh, Pa.

Shattuck Hotel, Shattuck & Allston Way, Berkeley, Calif.

UTAH SECTION

Monday, November 9, 1959—Social Hour 6:30 P.M., Dinner 7:30 P.M., Meeting 8:30 P.M.

"The Role of the Industrial Engineer in the Steel Industry," by J. E. Angle, Vice President Industrial Engineering, United States Steel Corp., Pittsburgh, Pa.

Grand View Country Club, Provo, Utah

YOUNGSTOWN SECTION

Monday, November 23, 1959—Social Hour 6:30 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"1959 Collective Bargaining in Steel—A New Approach," by William T. Hogan, S.J., Professor of Economics and Director, Economics Program, Fordham University, New York, N. Y.

Mahoning Country Club, Girard, Ohio

by Donald A. Jenter, Application Engineer, Reliance Electric and Engineering Co., Cleveland, Ohio

Increased Production Through Electrolytic Tinning Line Modernization

. . . . the cost of increasing the speed of an existing tinning line by 35 per cent was kept to a minimum by modifying existing electrical equipment and fitting it into a new drive and control system . . . .

MAXIMUM utilization of existing equipment has always been a good "watchword" in our increasingly automated society. In the past, though, equipment has been made prematurely obsolete in order to justify the newer, faster or more automatic machines so necessary to keep pace with the higher labor costs and overhead associated with our modern economy, while still returning a profit on the investment.

However, in these days of tightening economy, everyone is increasingly interested in the wise spending of the fewer available dollars. When new equipment is being considered to essentially duplicate the function of existing machines, one possible approach is to analyze the benefits and accompanying cost savings associated with rebuilding an existing device to increase speed and quality, and decrease maintenance.

To illustrate one steel plant's approach to such a desire, to review the specific configuration actually produced and installed, and to indicate the benefits derived from the revised installation, this article is a summary of the recent modernization of the No. 3 electrolytic tinning line installed at United States Steel Corp., Irvin Works Plant, near Pittsburgh, Pa.

This tinning line was one of the original nine "ferrostan" lines installed by United States Steel during World War II. Originally designed to operate at 600 fpm, the line had been modified from time to time to keep pace with the latest production and engineering developments. Among these modifications had been an increase in speed to 700 fpm.

It was desired to further modernize the line to achieve a top speed of 950 fpm with the best possible speed, tension and position control, while retaining the maximum possible amount of existing equipment. In addition, the ability to produce tinplate in coiled form was required, so recoilers were installed concurrent with the other modifications.

Since a processing line such as this is basically a constant torque application, it was necessary, for optimum performance, to modify the electrical system from a "voltage and field" design to "all voltage" control. Early in the investigation, it was determined that the drive bridle motor, acting as master or lead unit of the center section, could be safely operated with its field preweakened to the point where the additional speed could be sustained. In addition to saving the cost of installing a new motor and changing the existing gear ratio, the multitude of tachometers (used as reference for the pickling, plating and chemical treatment

Figure 1 — Variable-speed motors up to 15 hp drive groups of "sink rolls."

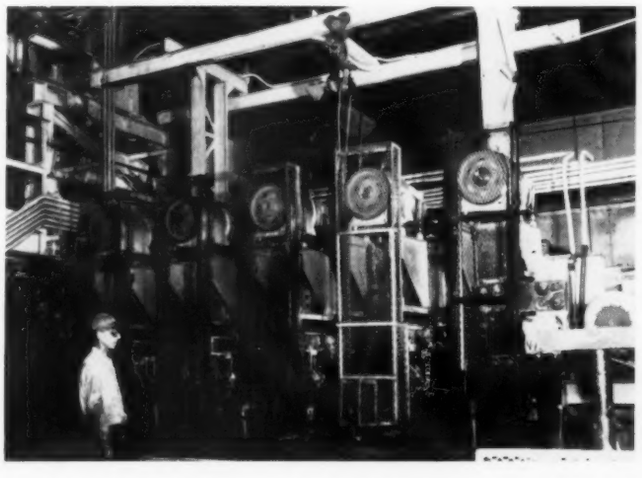
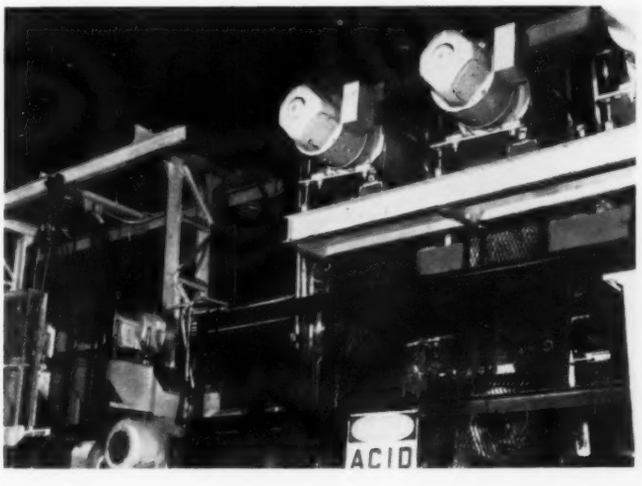


Figure 2 — Coupled to "sink rolls" by V-belts and pulleys, helper drives are subjected to an acid-laden atmosphere.



regulators) and pinwheel timers (used to classify pinholes and off-weight sheets) could be retained without mechanical change.

Approximately 20 3-hp motors were applied to individual conductor and deflector rolls throughout the line. This was desirable because of the reduction in torque available from the drive bridle motor due to operating with the field preweakened, and the extreme benefits from the addition of individual helper roll drives, both from the threading and operating standpoints. Further, four motors of varying sizes up to 15-hp were used to drive groups of "sink rolls." These motors, Figures 1 and 2, are coupled to the rolls by using V-belts and pulleys. The motor bases were so designed as to pivot on one side to provide approximately two in. of vertical adjustment through the movement of nuts on a threaded shaft. Those belts that couple groups of rolls required idler pulleys to obtain the necessary belt tightening.

Of the remaining motors in the center section, the existing auxiliary bridle motor (used to maintain tension in the strip passing through the oiler) was retained without change by replacing gears and bearings in the existing gear reducer, and the drag bridle motors (used to maintain tension in the strip passing through the pickling and plating tanks and so important in controlling the strip tracking through the line) were replaced by three specially compounded machines driving individual rolls of the bridle. The dual series fields of these machines utilize an equalizer connection to provide inherent load sharing without suffering the poor speed regulation encountered through the use of normal compounding or armature resistance.

Because of the extremely critical requirements of the entry end and the rather shallow entry loops that provide a total usable strip storage of less than 100 ft new machines were applied in all cases. To satisfy these requirements, these machines were designed for 300-volt operation, thus providing 20 per cent overspeed for loop replenishment, and sized to accelerate a 30,000-lb coil from rest to 950 fpm in only five seconds.

The existing shear motor was also used without modification. The field of this machine was preweakened to accommodate the shortest length of sheet to be cut. The modulated loop control system used to exactly synchronize the shear speed with that of the center section was designed with enough range to automatically compensate for the entire range of lengths to be cut.

Figure 3 — Three new booster motor-generator sets (center and right) replaced two smaller ones. The large original set (left) remains.

The existing classifier motors were used without modification, except that one additional duplicate motor with integrally mounted tachometer was installed on the first belt after the shear. This tachometer is used in conjunction with the speed regulator system. The gearing was, of course, changed to accommodate the higher line speed.

After determining the desired motor ratings, it was necessary to adapt the generating equipment to insure successful operation of the strip propulsion equipment in the new system. The existing main motor-generator set contained three 75-kw generators and two 50-kw exciters used for plating generator excitation and general purpose excitation. These units were retained for use in the new system by paralleling the existing fields on the 75-kw generators to obtain faster response through "forcing." These generators supply:

1. The main drive motors in the center section.
2. The helper drive motors in the center section.
3. The shear.

The exciters on the main motor-generator set were not changed.

The two small existing booster motor-generator sets were removed and three new sets, Figure 3, were installed. One of the new sets contains individual generators for the motors of the entry end. Overvoltage was included in the design of these units to provide overspeed of the entry section for loop replenishment. Another of these new sets contains booster generators for certain machines in the center section. The drag bridle, auxiliary bridle and sink rolls each use one of these boosters. The remaining new set consists of four control exciters constructed with two fields. Three of these generators excite the single field, 75-kw main generators to give the capability of voltage reversal for jogging and regulation of zero voltage for stand-by. The remaining generator excites all main generators of the entry section. This configuration provides the capability of actually reversing the travel of the strip in the entry section automatically, if required by unusual operations such as starting with too much strip in the entry looping pit. The desired tension on the uncoiler, as preset by the operator, is maintained during such reversal.

With the motor and generator equipment finalized, it remained only to analyze the control devices to see what could be reused, and where space was available to install the new panels required for the modernization. Basically, all panels were retained, with the exception of one unit on which two slates were replaced, and the motor-operated rheostat panel which was entirely replaced rather than restack the resistors. The rheostat, incidentally, is now used only as a reference for the line speed regulator. Although there are other means available to obtain the timed rate of acceleration and deceleration, it was also necessary to use a cam limit switch type of arrangement to retain existing interlocks for other functions of the line which were not modified.

Of course, wiring changes were required on the remaining panels, but these were reasonably straight-

forward and consisted for the most part of deletion of switching equipment, such as contactors and field accelerating relays no longer required due to the fact that these functions were designed into the new regulator circuitry. Even though many new relays were required by the new control scheme, the control devices that were disconnected almost exactly balance the additions. In addition, three new relay panels were installed to function as power distribution and protective panels for the new motors powering the conductor and sink rolls throughout the line. These balance exactly three old panels removed entirely from service.

The heart of this line, like any other complicated processing line, is the regulating system. The existing system utilized regulators of the "rocking arm" variety which not only lacked the accuracy and speed of response required in this application, but also were becoming increasingly hard to maintain due to the difficulty in obtaining spare parts. The replacement regulators installed on the strip propelling equipment of this line, including those for the recoilers, number 15. Here is how they are applied:

1. Two uncoiler tension (current) regulators, one is applied to each uncoiler.

2. One entry section speed/position regulator, utilizes a speed signal from the center section with a No. 1 loop position signal as a vernier. This ± 10 per cent vernier adjustment is provided by the output of a modulated loop controller mounted less than two ft from the bottom of the entry looping pit and containing four photoelectric cells that cover only an additional 16 in. of pit depth. Thus, a vertical loop movement of 16 in. will vary the speed of the entry section ±100 fpm to maintain the required loop position.

3. One intermediate loop pinch roll speed/position regulator exactly and automatically averages speed signals from the entry and center sections under all operating conditions. Extreme accuracy is required during coil changes to insure even depletion of both of the rather shallow loops. Another modulated loop controller is used to provide vernier adjustment of the loop position in the No. 2 pit.

4. One center section speed regulator operates on the generator voltage. The specifications required only an accuracy of two per cent, but the present system as installed is accurate within ½ per cent, or equivalent to less than ±5 fpm. This precise speed regulation is coupled with a speed of response of all regulators in the entire system that allows acceleration of the complete tinning line from rest to full speed in less than 10 seconds.

5. One drag bridle tension (current) regulator.

6. One conductor roll torque (current) regulator.

7. One sink roll torque (current) regulator. Since rolls that are immersed in a liquid lose traction on the strip at higher line speed due to "pumping "action, a rather sharply defined speed "limit" is required to prevent scratching the strip on line slowdown.

8. One auxiliary bridle tension (current) regulator.

9. One shear speed/position regulator utilizes as its input a voltage signal from the center section modified by a loop position signal of enough magnitude to cover speed variations due to changes in cut length. This vernier signal is obtained from a modulated loop controller similar to those applied to the entry looping pits and is also capable of reversal, if required to position the loop for starting.

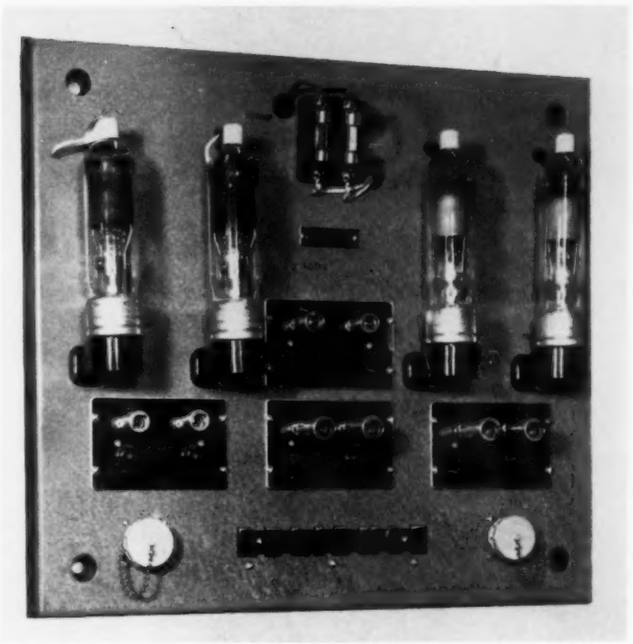


Figure 4 — The all-electronic, analog-type regulators need no rotating output stage for power amplification or impedance matching.

10. One classifier speed regulator is accurate within ½ per cent as required to follow the shear speed, thus maintaining spacing of the sheets, and allowing proper operation of the "single sheet" classifier system.

11. Two recoiler generator tension (current) regulators, one for each recoiler.

12. Two recoiler motor counter-emf regulators, one for each recoiler.

With the exception of the current and voltage regulators, very stringent requirements have been noted for the regulating system. These prove to be difficult problems for the designer of feedback control systems, because speed and position regulators are inherently hard to stabilize while retaining the desired response. For speed regulators, this is due to the fact that time constants of the motor and tachometer are cascaded onto generator and regulator time constants. For position regulators, an inherent 90-degree phase shift is present, since a regulator system must integrate the position signal.

The regulator picked to do this job was basically an all-electronic, analog-type unit requiring no rotating output stage for power amplification or impedance matching. It is shown in Figure 4.

The panel itself has a mean open circuit voltage gain of 10,000 to 1—for example, a 0.025-v d-c change on the input could vary the d-c output 250 v—and essentially an infinite power gain since the grid of a vacuum tube operates without conducting current. Although this large gain is seldom required, it is possible to easily reduce the system gain to the required value. On the other hand, it is impossible to achieve more in those cases where it is required for extremely fast response or when instability becomes a problem. The fact that power drain from the associated system is measured in milliamperes instead of in amperes is also important

Figure 5 — A portable test fixture with screw-type connectors checks electronic panels and individual elements in five minutes.

when loading of the measured variable cannot be tolerated.

Although vacuum tubes have demonstrated their reliability in the steel industry through their use in pin hole detectors, modulated loop controls and other electronic devices; it must be recognized that they, like any other device, are subject to failures. With this in mind, the regulators on this line are of the so-called "dual-circuit" variety. In other words, each tube, resistor, capacitor, rectifier and coil is duplicated and arranged in parallel circuitry so that in the event of failure of one leg of the network, the other is capable of sustaining uninterrupted operation. A portable test fixture, Figure 5, equipped with screw type connectors to match the receptacles provided on each regulator allows a rapid—less than five-minute—panel operation

Figure 6 — The unitized regulator construction features specialized electronic circuits embedded in blocks of solid plastic.

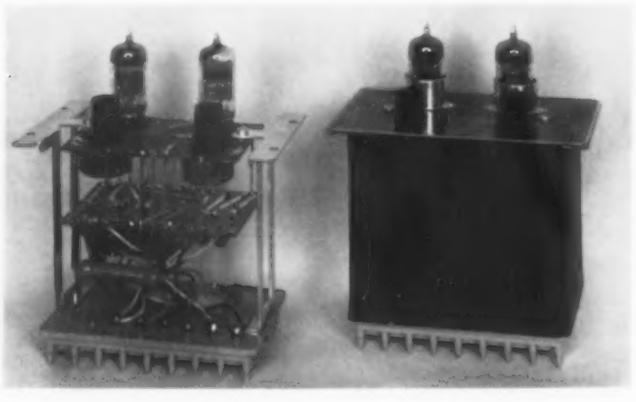


Figure 7 — Ten new regulators are mounted on new racks installed as sub-panels behind existing panels.

check and individual element check during convenient line shutdown periods at up to 6-month intervals.

If components have failed, replacement is simplified by the unitized construction of the regulators, Figure 6.

In addition to these features, all fifteen of these regulators are exact duplicates, providing complete interchangeability and ease of maintenance, since personnel need only become familiar with a single type of unit.

Ten of the 15 regulators, Figure 7, are mounted on five new panels installed as subpanels behind the exist-

Figure 8 — The recoiler control equipment, including its regulators, is installed in the main floor control room next to the line.

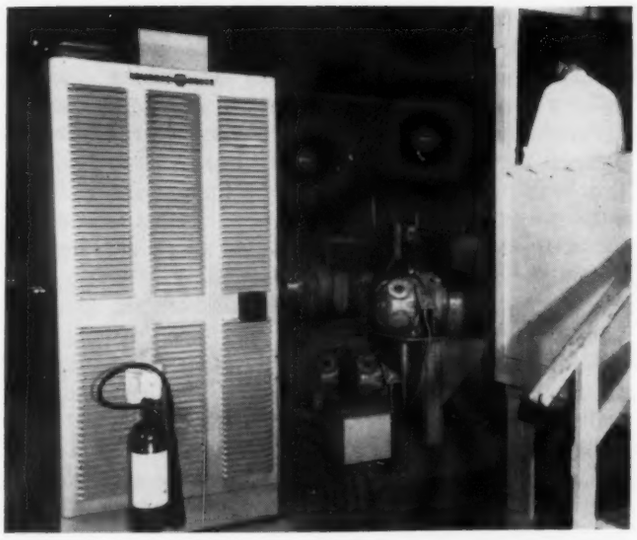


Figure 9 — This self-ventilated, self-supporting cabinet, adjacent to the end of the line, holds the classifier drive control equipment.

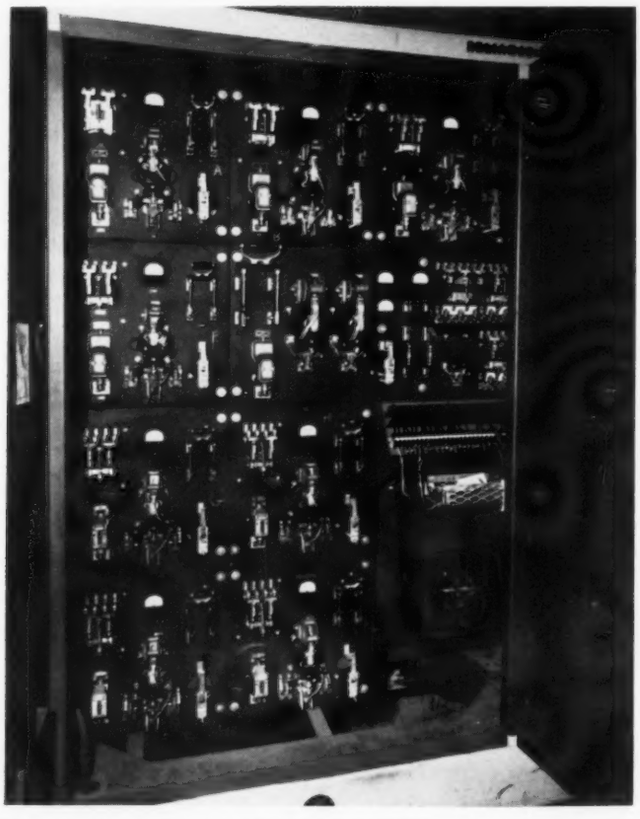


Figure 10 — The classifier drive control relays and contactors are mounted exclusively on slate panels.

ing panels already discussed. The recoiler equipment, Figure 8, including its four associated regulators, is installed in a control room on the main floor level adjacent to the line.

Having made maximum utilization of all existing space, the remaining problem of the classifier control equipment was yet to be solved. The only available space seemed to be on the mill floor adjacent to the line. This environment was not conducive to proper operation of exposed electrical control equipment, even if such an installation could be tolerated from the safety standpoint.

In view of this, it was necessary to provide what is commonly called a "packaged" drive. This self-ventilated, self-supporting cabinet, Figures 9 and 10, contains the classifier generator, constant potential exciter, electronic regulator and all contactors and relays required for operation of the classifier motors. It is practically self-sufficient in that less than ten wires to the control panels for the remainder of the line are required to interlock the "tandem start" and "emergency stop" circuits. Note that the relays and contactors are exclusively mounted on slate panels.

The modification of the line, excluding the recoilers and classifier which required substantial mechanical changes, was accomplished under a single contract. Coordination of the design, manufacture and installation of the great amount of electrical equipment, but relatively small amount of new mechanical equipment, was centralized to insure successful operation.

Such is the story of the modernization of a large processing line to a configuration equaling in performance the most modern line in the steel industry today. It is more than merely a summary of the details connected with the improvement of a particular line realized by increasing the line speed more than 35 per cent and reducing maintenance downtime, through the use of more reliable and simply maintained devices, all at a fraction of the cost of a complete new line. It is an indication of the benefits to be derived from such an approach to any modernization problem.

To keep pace with our rapidly changing technology and increasing costs, the coming years will be highlighted by higher line speeds, thinner gages, more accurate control and, in general, more stringent requirements on all types of electrical devices applied to metal processing equipment. The electrical manufacturers have anticipated this evolution by designing maximum flexibility into their equipment and are even now ready to solve some of these problems which will become more evident through the coming years.

Discussion

PRESENTED BY

J. C. DAVIS, Electrical Engineer, Irvin Works, United States Steel Corp., Dravosburg, Pa.

E. H. BROWNING, Manager, Metal Working Section, Industrial Engineering Dept., Westinghouse Electric Corp., East Pittsburgh, Pa.

D. H. JENTER, Application Engineer, Reliance Electric and Engineering Co., Cleveland, Ohio

HOWARD N. COX, Application Engineer, General Electric Co., San Francisco, Calif.

ALLEN C. BAKER, Gustav Hirsch Organization, Inc., Columbus, Ohio

J. C. Davis: The regulating systems on the line are made up of electronic control elements as described and are up-to-date with respect to recent advances in the electrical art. Experience to date shows promise of very satisfactory performance from the maintenance standpoint, along with certain operating advantages such as greater accuracy and faster speed of response, which were anticipated during the initial design stages.

Since controlled field studies on the useful service life of the electronic components in these regulators is difficult to make, a broad generalization on service life is not practical either since individual circumstances may vary widely. However, in view of the promising results so far, we feel that to obtain tolerable operation, a complete tube check should be made every three or four months. Obviously, even with the "dual-circuitry" feature incorporated in these regulators, complete neglect is not feasible since it is recognized that the electronic elements have a limited life.

In order to improve maintenance procedures and to help build familiarity with the equipment, a short training school for all maintenance personnel was conducted to reveal and emphasize features that are normally hidden and difficult to explain. Specific minimum test and maintenance procedures were outlined with the idea that standardized techniques using a portable test fixture would make it possible to detect and correct changes in the regulators. Unless a person is thoroughly acquainted with the testing and maintenance requirements, he can do more harm than good, and he might better leave the equipment alone.

E. H. Browning: A number of those original electrolytic tinning lines that did yeoman service during the early 1940's have been revamped and are today performing well above their original speed levels. This has generally required more drive horsepower, more plating power, more reflow power, and improvements in line controls to satisfy the higher speeds and the increasing requirements for better quality product at lower unit cost. On some lines, such as the one treated by the author, the change in can companies demand from base boxes to coils has meant the addition of coilers.

Why were electronic tube type regulators used throughout instead of magnetic amplifiers? The greater reliability of magnetic amplifier as compared to vacuum tubes and gas-filled power tubes is certainly established in the steel industry. Although the minimum burdens imposed by the electronic circuits on the signal source is very low, it certainly does not seem to be a too valid consideration in regulating systems of the type required on tin lines with exception, perhaps, of certain loop regulators. Also the citing of regulator voltage gain values of the order of 10,000 or 20,000 to 1 is not valid when considering circuits associated with a rather low speed of tin line operation of 950 fpm.

D. H. Jenter: I believe that it is not necessarily true that an electronic regulator need be less reliable than a magnetic amplifier in the particular configuration which we are talking about here. Even if we did start by accepting the premise that electronic regulators may be less reliable, I believe we may say that their application is certainly simpler when you are trying to rebuild an existing device. Also, as I pointed out, each of these regulators is an exact duplicate, and a maintenance man need become familiar with but a single type of unit.

E. H. Browning: How much, percentage-wise, was the actual connected horsepower and kilowatt supply of the line increased during the revamp to provide the increase in speed of operation of 35 per cent?

D. H. Jenter: I have never taken the time to calculate the percentage increase in horsepower, but just roughly the drive bridle motor was originally a 60/75-hp, 400/1600-rpm machine. Twenty-one 3-hp motors added to the center section total 63 hp so actually the available percentage addition is somewhere close to 100 per cent. I expect, however, that their actual loading approximates the 35 per cent quoted by Mr. Browning.

E. H. Browning: It was not clear as to what modification was made in the provisions for accelerating and decelerating the line. Is a time-of-travel function of a motor-operated rheostat used as the speed pattern or is a rate-of-rise of voltage network employed with a rheostat serving to preset and adjust the desired operating voltage or speed level?

D. H. Jenter: The motor-operated rheostat is used as the acceleration and deceleration setting media, as well as the reference for the speed regulator. The feedback, of course, is a tachometer on the drive bridle.

E. H. Browning: Were there changes made in the plating and reflowing power facilities on the line to match the increased speed of operation or was the original equipment overrating sufficient?

D. H. Jenter: There were no changes made in the plating and pickling equipment, recognizing that at higher line speeds, heavier plating could not be accomplished.

E. H. Browning: Regarding the drag bridle drive the author mentions the use of dual series, cross-connected fields for load sharing purposes. Were rectifiers for blocking purposes used in this arrangement?

D. H. Jenter: The equalizer connection of the drag bridle motors is accomplished without rectifiers in the dual series fields of any machine. One field is connected cumulatively and one differentially. The differential fields are paralleled on all three of the motors. The cumulative field acts only with its particular motor.

Howard N. Cox: Realizing that a tinning line is one of the most complex processing lines, it is interesting to note that it required some 30 new motors, greatly increased drive generating capacity, and the addition or replacement of 15 regulators to bring the line up to today's standards. This includes only the line drive equipment and does not include the cleaning, plating and reflow equipment, and regulators. Since this line is only approximately 15 years old, this well illustrates how rapidly systems technology is advancing to meet today's needs in the industry.

I would like for the author to comment on the following: How is the 20 per cent overspeed on the entry section obtained with only a plus 10 per cent range in the No. 1 entry loop control? With only 100 ft of storage in the entry loop, it would appear that the center section must be partially decelerated to avoid exhausting the loop when welding. To what speed is the center section reduced, and what is the effect on tinplate quality?

D. H. Jenter: With only 100 ft of usable storage in the entry looping pits the center section must be decelerated when coils are changed in the entry section. This reduction is down to somewhere in the neighborhood of 250 to 300 fpm. I believe as the operators become more familiar with the control, it will gradually approach the 300 fpm. Although the control range of the modulated loop system provides barely 10 per cent vernier action, this is not a factor in loop replenishment. A fixed overspeed signal is applied to the applicable regulator whenever the loop leaves the modulated range.

Howard N. Cox: I assume the three motors of the

drag bridle are of different ratings, or at least are arranged to produce different torques as indicated by the well known rope and pulley formula. Was any special provision made to adjust the series field of the motors for proper torque balance during installation such as shunting resistors? It has been our practice to use straight shunt motors with inherently stable speed characteristics.

To achieve proper load sharing, it is necessary only to add line resistance to the two motors with the lowest IR drop to make the complete circuit drop of each motor the same. This can be done without excessive speed regulation and make it very easy to adjust for different cable drops, etc. Furthermore, it is not clear to me why you express concern about speed regulation on the drag bridle when it is actually tension regulated.

D. H. Jenter: There was no attempt made to shunt the series fields of any of the three machines. Their ratings were basically 10, 15 and 20 kw. They were designed for load sharing in the engineering stage, were built and were acceptable in the field. Of course, the shunt fields were adjusted to provide the correct gear-in speed. Load balance between the motors can also be modified by an adjustment of the shunt fields.

I did not mean to imply that these machines were speed regulated. I merely tried to indicate that the speed drop from no load to full load, using a compound machine, is excessive and greater range must be designed into the booster generator to cover such a speed variation.

Allen C. Baker: I think our installation problems typify the feasibility of this type of continuous line revamp or modernization.

First in the location of equipment we found it necessary to design new motor bases, ways and means for belting, guarding and adjusting of same. Primarily the installation of conduit and wiring are the same as in any new installation. ▲

Available Translations

As a service to readers of the *Iron and Steel Engineer* a list of translations from foreign articles is being printed intermittently. Articles selected for this listing will be those of primary interest to the American steel plant operator. The papers may be obtained from the British Iron and Steel Industry Translation Service, The Iron and Steel Institute, 4 Grosvenor Gardens, London, S.W. 1, England. All correspondence concerning price, ordering, and so forth should be directed to that address.

1153 MAYER, K. E., *et al.:* "Automatic Control of Basic Converter Heats," *Stahl u. Eisen*, 1958, Nov. 13, pp. 1670–1676.

1198 BROSCH, H., and H. WABUREK: "Production Control in Rolling Mills by Means of Communicating and Signalling Systems," *Stahl u. Eisen*, 1959, Jan. 8, pp. 23–32. (Summary: Programming. Working triangle: Main control stand, soaking pits and cranes. Written information as basis. Instructions for blooming mills and bloom shear; finishing trains. Warning of breakdowns. High-capacity finishing trains. Fundamental principles.)

1215 PEPPERHOFF, W., H. and J. BRACKSIECK: "Study of Flame-temperature Radiation in an Open-hearth Furnace," *Stahl u. Eisen*, 1956, Nov. 1, pp. 1453–1456. (Abstract *J.I.S.I.*, 1957, July, p. 364: The authors measured the flame temperatures at various parts of a gas- or oil fired open hearth furnace (system Maerz) by a new color-brightness pyrometer that measures temperatures up to 3000 C. The error at 2500 C is of the order of one per cent; the response is not quoted. The authors claim that by use of the new pyrometer it will be possible to study the complete and complex radiation phenomena in open hearth furnaces at reasonable cost.)

1235 SOKOLOVSKII, V. I., *et al.:* "Experimental Investigation into the Cold Reducing of Tubes," *Stal,*' 1958, Dec., pp. 1112–1117.

1294 WEBER, J.: "Formation of Steam from Waste Heat and Efficiency of Dust Removal from the Converter Waste Gases of a Water-cooled Converter Stack by Cycloses," *Stahl u. Eisen*, 1959, March 5, pp. 291–295. (Summary: Investigation of the thermal and dust problems of a water-cooled-converter stack. Dust removal by cyclones at the Rochling'sche Eisen- and Stahlwere at Volklingen. Cooling of converter waste gases as a necessary condition for efficient dust removal. Formation of steam in the cooling water circuit of the converter stack. Heat balance per minute and heat balance per average unit of time. Additional importance of water-cooled stacks for the utilization of the waste heat. Efficiency of dust removal. Grain size classification of crude-, cyclone-, and residual dusts. Efficiency of dust removing equipment. Iron and iron oxide content of the precipitated and residual dust.

922 ECKINGER, K.: "Modern Basis for the Development of Crane Bridges," *Stahl u. Eisen*, 1957, Jan. 10, pp. 15–23. (Abstract J.I.S.I., 1957, July, p. 371: The author compares German and American design principles for iron and steel works cranes and discusses the various types of construction from the static and dynamic point of view. He quotes model tests on box girders and stresses their merit, particularly the multiple-cell box type.)

1194 KORNFEL'D, V. N.: "Efficiency of Intensified Open-hearth Melting with Oxygen under Suitable Operating Conditions," *Stal'*, 1958, Dec., pp. 1095–1102.

1228 VOIGT, H., and G. SCHMALHAUS: "Influence of Regenerator Design on the Preheating of Air and Gas in Triple-gas Fired Open-hearth Tilting Furnaces," *Stahl u. Eisen*, 1959, Jan. 22, pp. 80–88.

1230 IWEINS, R.: "The Manufacture of Cast Steel Rolls at the Ougrée-Marihaye Works," *Rev. Univ. Mines*, 1945, Sept. 15, pp. 122–128. (Abstract J.I.S.I., 1947, Dec., p. 635: The author compares cast with forged rolls and shows the evolution of the present process of manufacturing cast rolls at the Ougrée-Marihaye foundries. Details of steels used are also given.)

AISE Papers Award Winners Announced

WINNERS of the AISE Kelly Award for the best 1958 papers were announced at the annual banquet of the AISE, September 30. First place went to Carl F. Bessent, supervisor, mechanical maintenance, Bethlehem Steel Co., Sparrows Point, Md., for his paper "Techniques in Rebuilding a Blast Furnace."

This paper furnished a general description of techniques, innovations and methods used in blast furnace repairs at the Sparrows Point plant of the Bethlehem Steel Co. All phases of the job, including planning, preparation and performance of the relining are discussed, with special emphasis placed on materials-handling systems and time-saving procedures. The paper was originally published in the February, 1958, *Iron and Steel Engineer*.

Second place winners were F. Slamar, research engineer, and G. E. Kennedy, technologist, Applied Research Laboratory, United States Steel Corp., Monroeville, Pa., with their paper "Turn-Up and Turn-Down in Hot Rolling." First published in the March, 1959, *Iron & Steel Engineer*, this paper discusses simple hot mill passes studied on laboratory mills. Results indicate that the most significant factors which affect the amount of turn-up and turn-down is the surface-speed ratio of the top and bottom rolls. If the pass design is truly symmetrical, factors such as angle of entry, amount of edge working required, do not significantly alter the speed-ratio needed to produce a straight piece.

Emil Kern (left), president of AISE, congratulates A. E. Cichelli, F. Slamar and C. F. Bessent as they receive their awards for the best papers of 1958.

The third place award was given to A. E. Cichelli, lubrication engineer, Construction Engineering Dept., Bethlehem Steel Co., Bethlehem, Pa., for his paper, "Mill Gearing as Viewed by a Lubrication Engineer." This paper, published in the September, 1958, *Iron and Steel Engineer*, points out the difficulty in applying small gear design techniques to large steel mill equipment, but discusses how the procedures of AGMA and those of Buckingham, intelligently applied, may indicate when failure may be expected.

Another close runner-up paper which received honorable mention was that by Harry Angel, electrical engineer, Bethlehem Steel Co., "Protection Against Prolonged Delays on Main Drive Electrical Equipment."

The Kelly award carries prizes of $300, $200 and $100 for first, second and third place respectively. The award was established in 1943 to honor John F. Kelly, managing director of the AISE from 1917 to 1934, and to perpetuate the memory of his achievements in the advancement of the Association.

The award is made each year by the board of directors of AISE upon the recommendation of the editorial and executive committees of the Association.

Rules of the award:

1. The award shall be given annually to the author of the best paper adjudged of greatest value in the advancement of engineering or operating practice in the iron and steel industry.

2. The entries for each judging shall be the papers published in the *Iron and Steel Engineer* during each calendar year, although some may have been presented at meetings in the previous year.

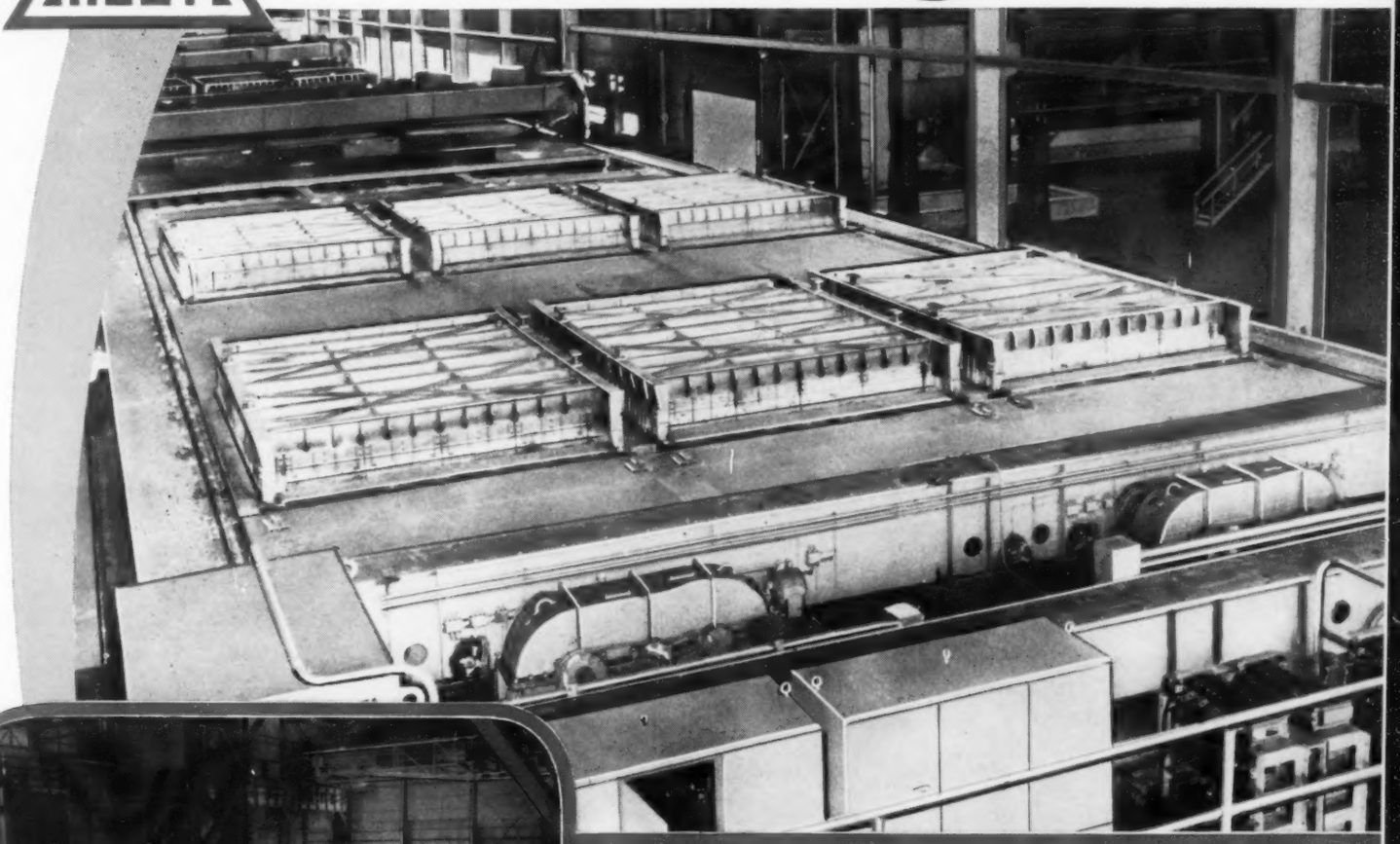
Voluntary contributions of papers not presented at meetings but published by the AISE are also included in the judging.

3. To be eligible for the award, the author must be directly employed in the iron and steel producing industry. The author need not be a member of the Association of Iron and Steel Engineers.

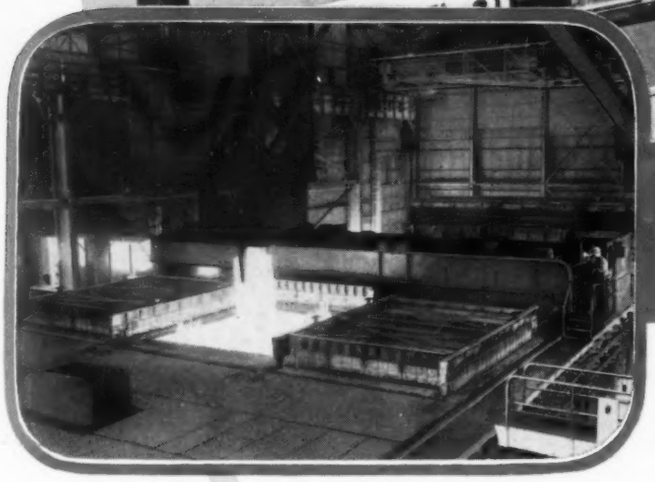
4. The award shall be made at the annual fall meeting following the close of the calendar year.

5. The award shall be made by the board of directors of AISE on the recommendation of the executive committee of AISE. ▲

Automatically Controlled Soaking Pits



NINE-HOLE SOAKING PITS designed and constructed for National Tube Division, U. S. Steel Corporation, Lorain, Ohio.



Ingot drawing at a Rust recuperative soaking pit at Lorain Works

The two-way, top-fired, recuperative soaking pits feature completely automatic temperature, fuel air ratio and furnace pressure control. Three batteries of three holes each; hole size: 12′ 6″ wide, 15′ long and 15′ deep. Constructed for Lorain Works, these soaking pits were designed to utilize Rust tile recuperators, which pre-heat air for combustion to 1300°F., resulting in increased efficiency and fuel economy.

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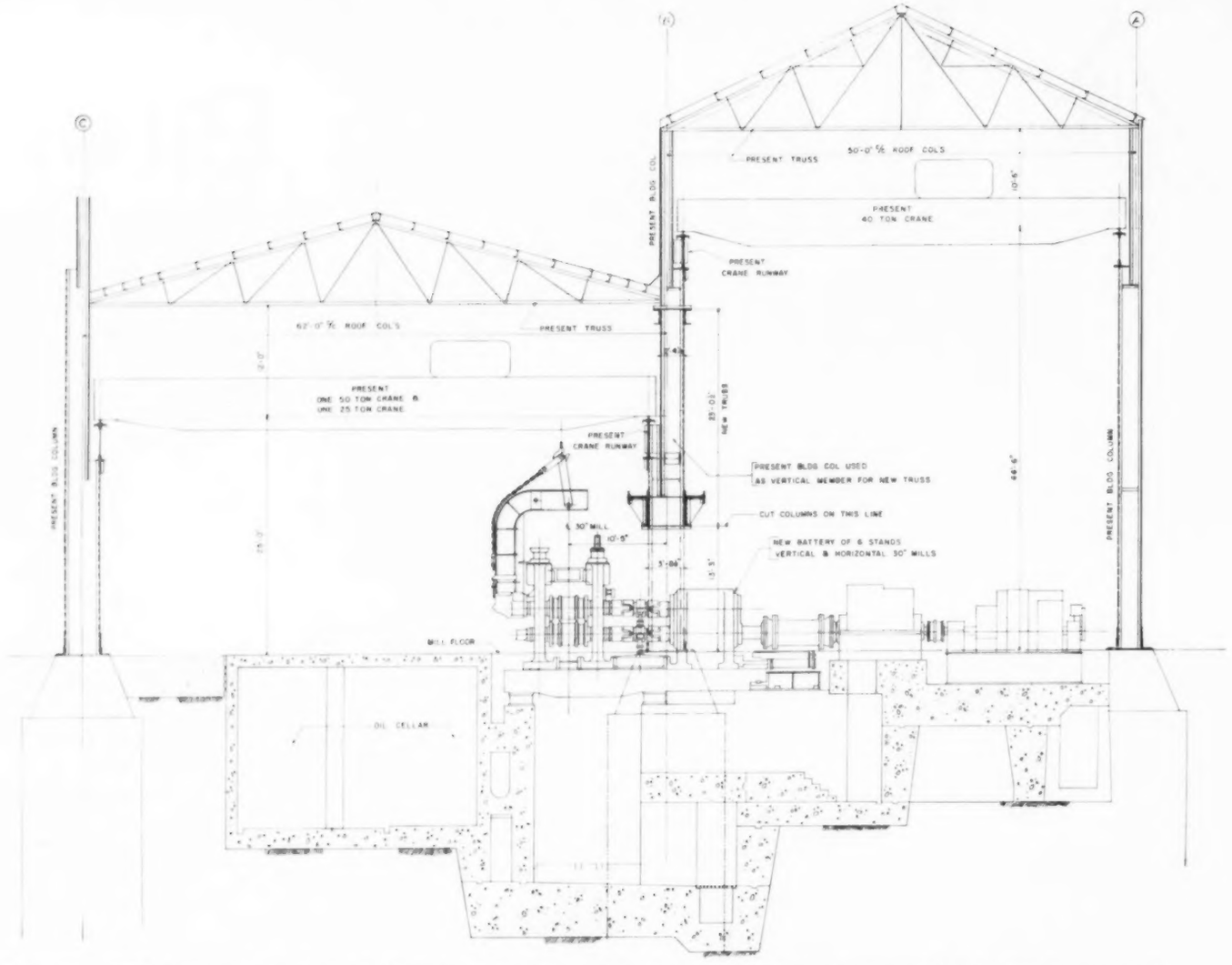


Figure 1 — This cross section through the new 30-in., 6-stand mill shows building columns which had to be removed.

Ingenious Construction Minimizes Production Delays

by Harry Ellsberg, Chief Structural Engineer
Giffels and Rosetti, Detroit, Mich.

A difficult problem faced Pittsburgh Steel Co. in keeping a 4000-ton per day steel mill in full operation while radical changes were underway in its construction. This change-over was recently completed at the Monessen, Pa., plant. Modernization of the 43-year old mill involved replacing the plant's 2-stand billet mill with a new 30-in. 6-stand mill resulting in a straight line operation, thus increasing the daily capacity.

A number of columns supporting the roof and the heavy crane runways over two adjacent aisles were removed, while the 40 and 50-ton capacity cranes, one in each adjacent aisle, were maintained in alinement and in full operation.

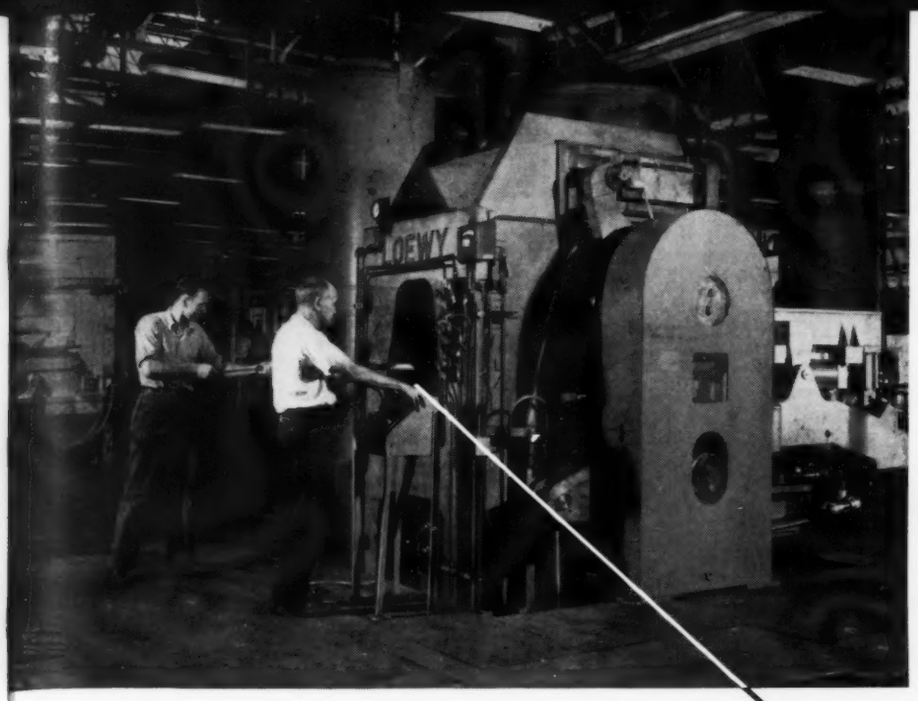
The removal of these columns, which were at 20 ft-0 in. centers, to obtain a span of 100 ft-0 in. on the column line, permitted the installation of the new six 30-in. stands, located on this column line.

The solution of this problem was met by cutting off the lower portion of the four columns at a height of 13 ft-3 in. above the floor; incorporating the upper portion of these columns as vertical members of a new 100 ft-0 in. span truss which was assembled in the field; reinforcing the end columns to take the end reactions of the new 100 ft-0 in. span; designing the bottom chord of the new truss, and making it adequate for the eccentric vertical and lateral loads produced by the heavy cranes above; and by rearranging and strengthening the existing roof bracing system.

Since the mill was in full production and the cranes in operation throughout the program, the assembling of the new truss had to be completed first before the lower section of the columns could be removed.

As indicated by Figures 1 and 2, the following procedure was used:

1. The end columns, supporting the new 100-ft span truss were first reinforced as per design drawings; also the crane girder seats for all six columns involved were reinforced.



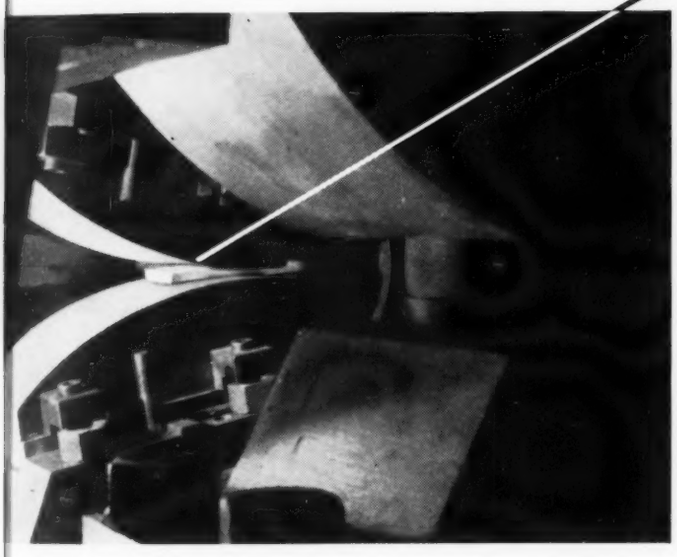
(Opposite)
Rectangular blade blank, withdrawn from electric furnace, is being inserted into automatic blade gripping and handling device.

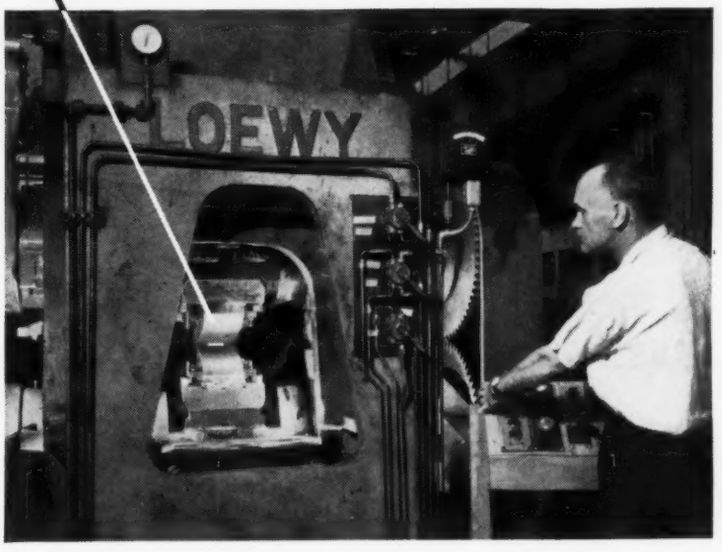
(Below, Left)
Blade blank is pulled through and shaped by oscillating sector roll dies. Two dies, with their lips rolling on each other through arc of oscillating length, impress upon the blank the air foil shape required.

(Below, Right)
At end of rolling process, oscillating rolls open up and rotate back to starting position. Simultaneously the blade handling device returns the shaped blade and releases it pneumatically from grip head. Note spur gear synchronization of oscillating rolls, pressure selector switch, and 2-hand control pulpit.

Blade can be re-rolled for further reduction until final shape and tolerances are obtained, either after re-heat cycle or cold.

WORKPIECE (blade blank)





LOEWY ROLL-DIE forges air foil shapes with up to 40% reduction in one pass!

A 4-stand oscillating roll-die forging installation which shapes high-strength, high-temperature alloys by hot and/or cold reduction is in successful pilot operation at the Tapco plant of Thompson Ramo Wooldridge Inc., Cleveland, Ohio.

Thanks to this new Loewy machine, jet engine compressor and turbine blades up to 7 in. wide and 27 in. long can now be mass produced by plastic forming to close tolerances and with insignificant loss of critical material.

Unlike other machines, which use mechanical drives in rolling, it operates hydraulically. It is designed for both hot and cold forming under adjustable and pre-selected forming pressure up to 1200 tons. Forming pressure is applied lineally across the shape of the workpiece with great advantage over conventional die forging methods.

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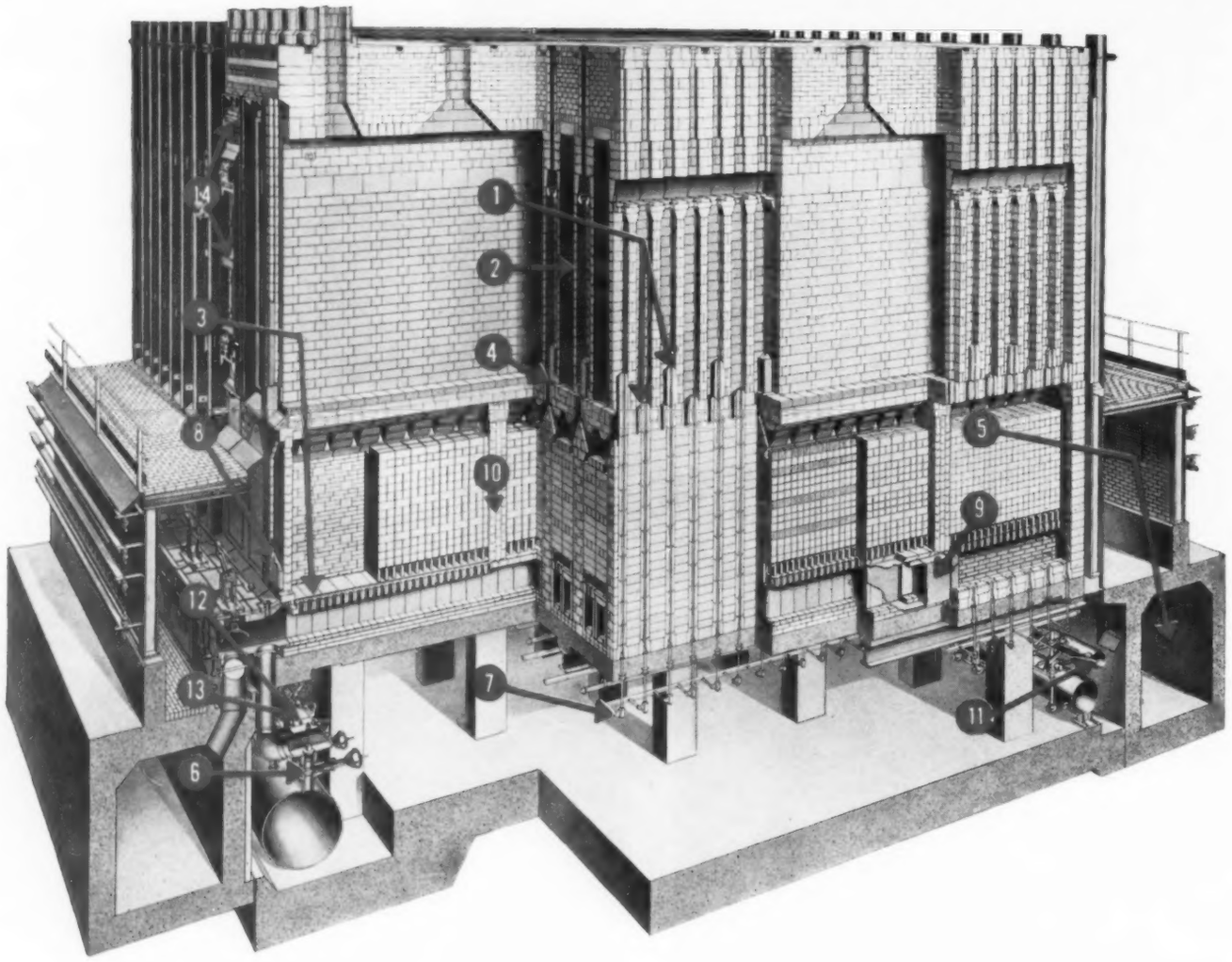

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2. **WALLS OF UNSTEPPED THICKNESS**—*vertical uniformity in heating with lean gas.*
3. **VENTURI PORTS**—*air, lean gas, and waste gases distributed uniformly through regenerators.*
4. **GRADUATED AIR PORTS**—*built-in regulation of air and lean gas.*
5. **COMBUSTION AIR SYSTEM**—*accurate control of combustion air, uniform ventilation of basement.*
6. **ORIFICE AND BUTTERFLY**—*for equalizing flow of lean gas to each regenerator.*
7. **STAINLESS STEEL PINS**—*precision distribution of rich gas to the burners, readily accessible for cleaning.*
8. **INSULATED STEEL FACE PANELS**—*air tight, reduce loss of heat from regenerators.*
9. **METAL FLASHING**—*no leakage between bus flues.*
10. **SHORT DIVISION WALLS, TRIPLE-THICK**—*the only regenerator area subject to cross leakage.*
11. **FORCED DECARBONIZING AIR SYSTEM**—*positive control of decarbonizing of burners.*
12. **SIMPLE LATCH AT EACH LEAN GAS REVERSING VALVE**—*change over entire battery from one gas to another within five minutes.*
13. **POSITIVE INTERLOCK AT EACH GAS REVERSING VALVE**—*air and lean gas cannot be admitted at the same time.*
14. **SELF SEALING OVEN DOORS AND SELF SEALING LEVELING DOORS WITH RENEWABLE SEALING EDGES**—*gas tight, easy maintenance.*
15. **HYDRAULIC DOOR MACHINES**—*smooth operation, low maintenance.*

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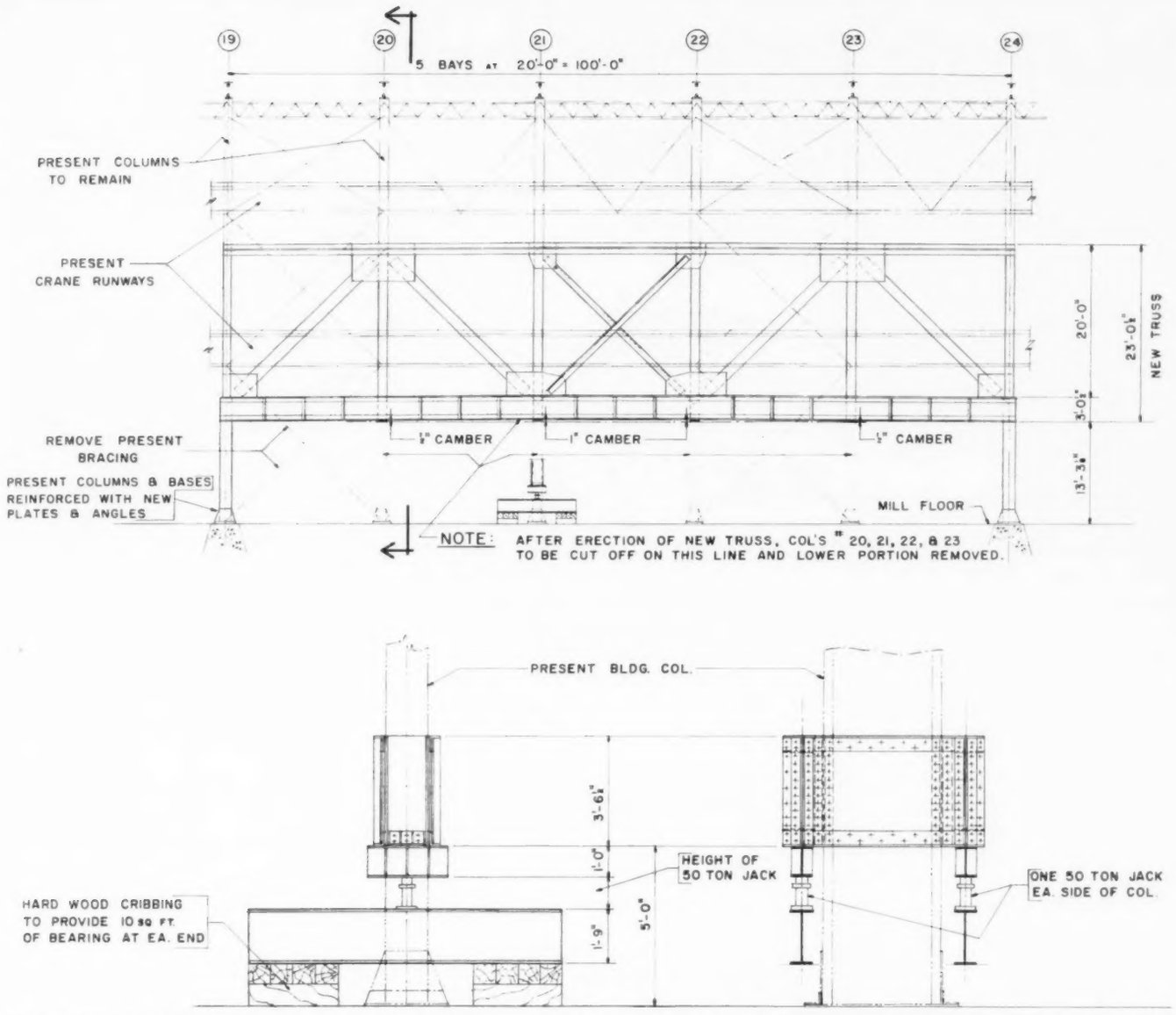


Figure 2 — The top drawing is an elevation of the new 100-ft truss. The bottom detail is the wedging-up arrangement for the old columns prior to constructing the truss.

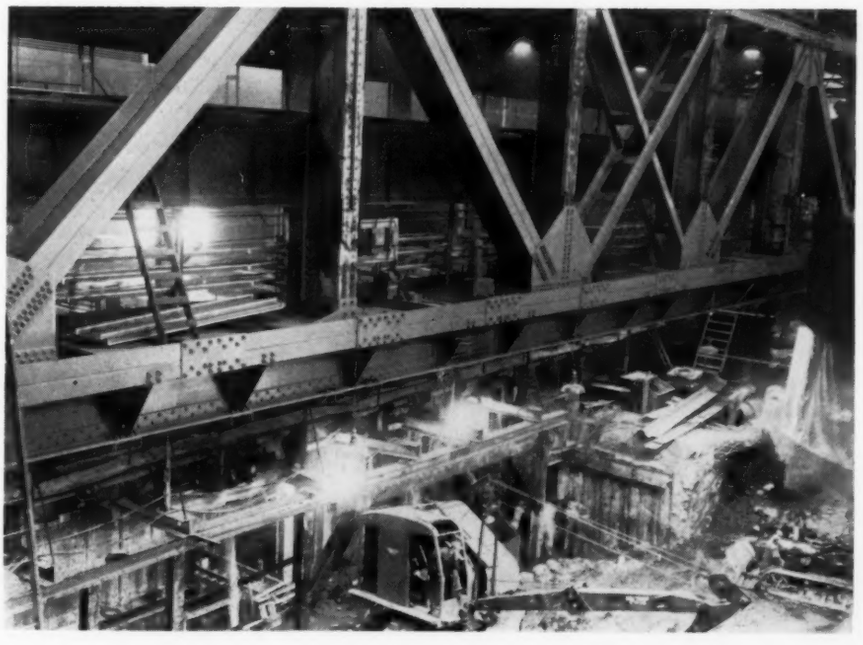
The roof bracing system was revised and reinforced.

2. The four columns to be removed were wedged up, one-half in. and one in., respectively, for the two end and the two middle columns, in order to take care of calculated deflection and transfer of load from the columns to the new truss. After the wedging-up operation was completed, the columns were blocked under the base plates.

3. Field work of assembling and riveting the new truss members provided one-in. of camber. After the truss erection, the lower sections of the four columns were burned off 13 ft-3 in. above the floor.

The underground work in this operation involved considerable engineering problems, some conception of this operation is shown in Figure 3. ▲

Figure 3—This project required much underground work.



Metal-Plastic Combination Material

For some applications thermo-setting, laminated plastics combined with metals have properties that are superior to either constituent.

MOST basic metals have, in recent years, been successfully combined with industrial thermosetting laminated plastics to multiply the practical values of both and thus, in fact, produce a new engineering material.

These new combination materials have opened broad new avenues of application in the metalworking field. Synthane Corp., Oaks, Pa., a leading manufacturer and fabricator of industrial laminated plastics, has been a pioneer in the development of combination materials, including laminates and steel, copper and other metals and nonmetals.

In addition to strengthening the metal with which it is combined, a plastic laminate decreases material weight without sacrificing strength; reduces the quantity of metals required; improves fabrication characteristics; and forms, in effect, a new material with a wider range of properties than either material possesses alone. In addition, users are provided with the dominant properties of both plastic laminates and metals.

Thermosetting plastics such as those made by Synthane are permanently set and cannot be softened or remolded. Synthane is a hard, dense material with many desirable properties in combination. It is made by applying heat and pressure to layers of fabric or paper impregnated with a synthetic resin. In the basic forms, Synthane is produced in sheets, rods, tubes and molded-macerated or molded-laminated parts.

Standard thicknesses for sheet grades range from 0.005 to 10 in. for certain grades. Sheet sizes are standard 36 x 36 in. and 36 x 72 in., but special 24 x 100 in. sheets are also available; sheets longer than 100 in. may be produced by hitch-curing in certain grades.

Laminated plastic tubes are generally round, but they may be square, hexagonal, oval, multiple-cavity or various other shapes as may be required. Tubing is available in diameters of $\frac{1}{16}$ in. inside diameter to 26 in. outside diameter, and in a wide range of wall thicknesses and grades.

Solid bar stock is also available in diameters from $\frac{1}{16}$ to 4 in. Molded tubing and rods are supplied in random lengths of 36 in.; standard lengths for rolled tubing are 18 and 36 in., but certain sizes and grades may be obtained in lengths up to 96 in.

Rods come in a variety of shapes, with round rods the most used forms.

Combination laminates are available in sheets, rods and tubes. In sheet stock, Synthane may be on either side, or between layers, of the other material, such as a metal; in tubes and rods, the plastic laminate is usually wrapped around the other material.

Theoretically, any material can be combined with thermosetting plastic laminates by adhesive bonding, but several combinations have become somewhat standardized. The laminates most used for combinations are paper-base phenolics such as National Electrical Manufacturers Association (NEMA) Grades XX, XP, XXP, and XXXP; and glass-base grades, such as G-10 and G-11, are among those frequently used for copper-clad laminates in printed circuit boards.

The improved material resulting from a laminated plastic bonded to a metal enables the designer to specify a combination of physical, mechanical and electrical properties that is unavailable in a single engineering material. A number of advantages accrue from such combinations:

1. Better strength-weight ratio.
2. Increased resistance to corrosion and chemicals.
3. Dimensional stability over a wide temperature range.
4. Improved fabrication characteristics.

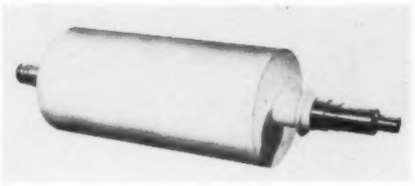


Figure 1 — The outside diameter and ends of this electrolytic tinning line roll are covered to resist the chemicals used in tin plating.

5. Reduced production costs.

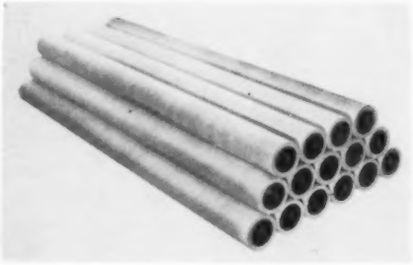
Adequate bonding of combination materials is always important. Generally speaking, adhesive formulations have developed to a point where today the actual strength of the bond is seldom a problem.

Attention is called to the versatility of plastic laminates being used with metals. There are many grades of Synthane, some of which are specially treated for particular applications.

A variety of design requirements exist in the different types of rolls used for electrolytic tin plating of steel strip. These plating rolls, Figure 1, which replace the conventional rubber-covered rolls, consist of steel cores covered with fabric reinforcement impregnated with several types of resins; the selection of the fabric and the resin depends upon the needs of each individual roll.

Bridle rolls, which prevent the steel sheet from buckling as it uncoils, have hard, abrasion-resistant

Figure 2 — Synthane-covered steel conveyor rollers resist wear and will not scratch highly polished steel plates.



Your Bethlehem forged roll will meet your specs exactly

When you place an order with us, you can do so with complete confidence that your specifications on size, shape, hardness, and finish will be met in full. Moreover, you can count on good deliveries. Call us whenever you need rolls for cold-rolling steel sheet, strip, and tinplate, as well as non-ferrous metals.

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BETHLEHEM STEEL

BETHLEHEM STEEL

surfaces; hold-down rolls are made to withstand effects of sulphuric acid. The plastic laminate on the latter insulates the roll from the electric current, preventing electrolytic deposition of tin on the rolls.

Laminate-covered rolls last more than three times as long as rubber-covered rolls, and also better resist acids; they are denser, thus eliminating embedment of foreign particles in the rolls—a factor which might mar the plate's surface; and laminated plastic rolls are tougher, thereby reducing the extent of edge cutting and gouging that results in excessive vibration and chatter during the high-speed plating operation. Steel tubing covered with a fabric-base phenolic laminated plastic sheet is used extensively for conveyor rolls for handling highly polished steel plate.

An interesting example of a well known process is the use of metal inserts and bushings with molded-macerated plastics in a widely used automatic screw machine which produces precision screw machine parts.

The success of its unique high-speed reversing clutch can be, in large measure, traced to industrial laminated plastic. To solve the problem of time lost in reversing movements in the productive capacity of high-speed automatic machine tools, an automatic screw machine clutch cone was developed. This reversing clutch's design feature a movable clutch cone of a molded phenolic plastic material which meets all the requirements of a high-speed clutch operation: light weight, great strength and good heat resistance.

Synthane's special plastic processing and molding techniques provided this important part, which gives longer service life, improved and quieter performance and lowers maintenance costs. In addition, the molded-macerated clutch cone is not distorted or deteriorated by the high speed or operating temperatures of up to 250 F.

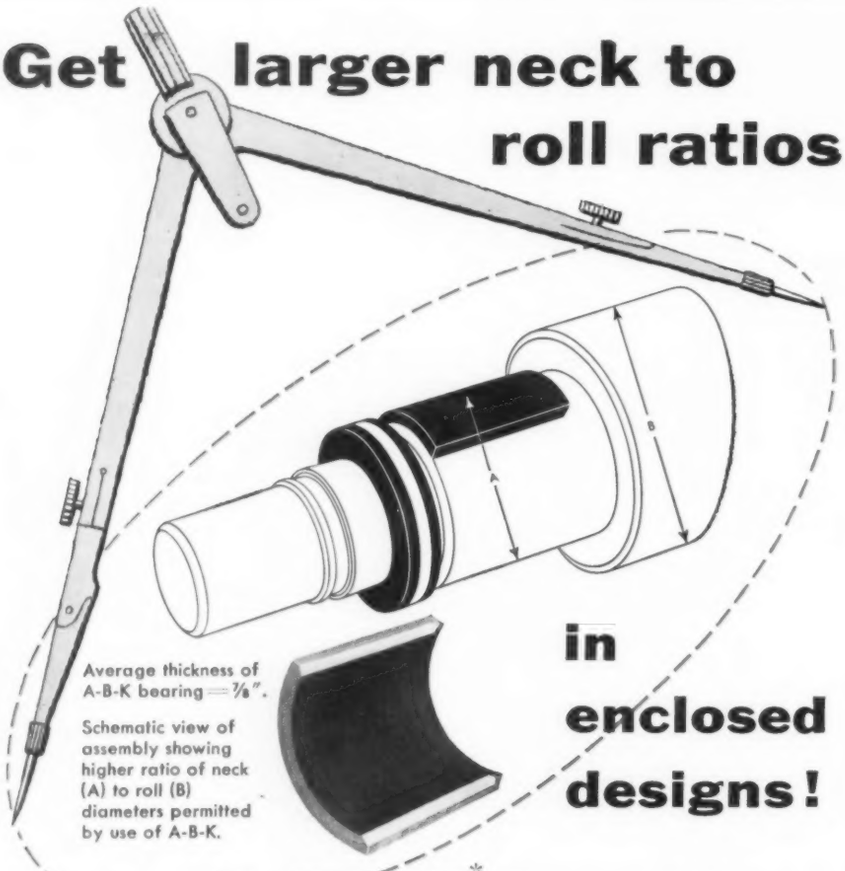
A steel salt-spreading roller, used by a potato chip manufacturer, was covered with laminated plastic to solve a corrosion problem. In using Synthane, this manufacturer combined the steel roller's crushing weight with plastics' corrosion protection.

Laminated plastic coverings on many types of metal rolls have been developed and perfected by Synthane Corp., and these have had important use in the textile industry as cover for pressure rolls. Strength, smoothness, cleanliness and resistance to chemical attack are the key qualities of plastic laminates in these applications.

Having superb insulating characteristics, laminated plastics are often used in the electrical industry as covers for copper buss and cadmium-plated steel switch bars.

Synthane laminated plastics, approximately one half the weight of aluminum, have a high strength-to-weight ratio, and high tensile, compressive, flexural and impact strengths; furthermore, laminates have the stability of steel, but are noncorrosive, and the finish can be better on plastic laminates, which are rust-proof, tough, resilient, abrasion-resistant, dimensionally stable and easily machined.

These and other useful properties, combined into one material and combinable with other materials, make laminated plastics especially versatile and useful elements in the metalworking industry. ▲



Get larger neck to roll ratios in enclosed designs!

Average thickness of A-B-K bearing = 7/8".

Schematic view of assembly showing higher ratio of neck (A) to roll (B) diameters permitted by use of A-B-K.

use A-B-K* bearings

No need to sacrifice roll neck diameters to keep down size and cost of bearing assemblies and housings. A-B-K bearings save space, permit larger, stronger roll necks—with cheaper, lighter weight parts. A-B-K laminated phenolic bearings have ability to absorb and cushion heavier impacts, and often outwear metal, many times. Grease and oil can be used for lubrication but water, alone, is often the answer. Ask our engineers for specific recommendations.

- Wear longer
- Won't score or heat check
- Light in weight
- Cut lubricant costs
- Save power

A-B-K
LAMINATED
PHENOLIC BEARINGS

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Superex is easily combined with other insulations such as Johns-Manville Thermobestos®, J-M 85% Magnesia or J-M Insulating Fire Brick.

Only Johns-Manville Superex insulation performs 3 ways better at high temperature!

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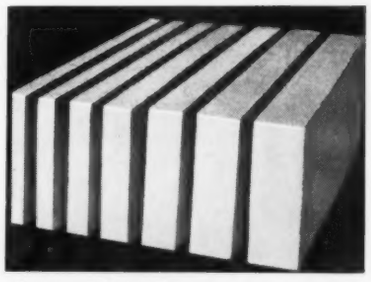
A block insulation formulated of diatomaceous silica and asbestos for furnace and other applications, Johns-Manville Superex brings many advantages to high-temperature service—each contributing to reduced construction, maintenance and operating costs.

Superex is installed with measurable savings in time and labor! It is easy to cut and handle . . . weighs only 2 lbs. per sq. ft. per inch thickness . . . available in a wide variety of large block shapes and sizes. At high temperature—the material's excellent insulating value, thermal stability and resistance to shrinkage keep fuel costs low. Equally important—Superex saves on maintenance, too . . . easily withstands the daily abuse of normal service.

Send for your copy of IN-190A, the 12-page design and technical data brochure. It lists suggested applications—gives complete heat transmission tables and performance data. *Write for it today.* Address Johns-Manville, Box 14, N.Y. 16, N.Y. In Canada, Port Credit, Ont.



Saves waste. Superex comes in 7 standard thicknesses from 1" to 4". Other sizes available on order.

JOHNS-MANVILLE

JOHNS-MANVILLE JM PRODUCTS

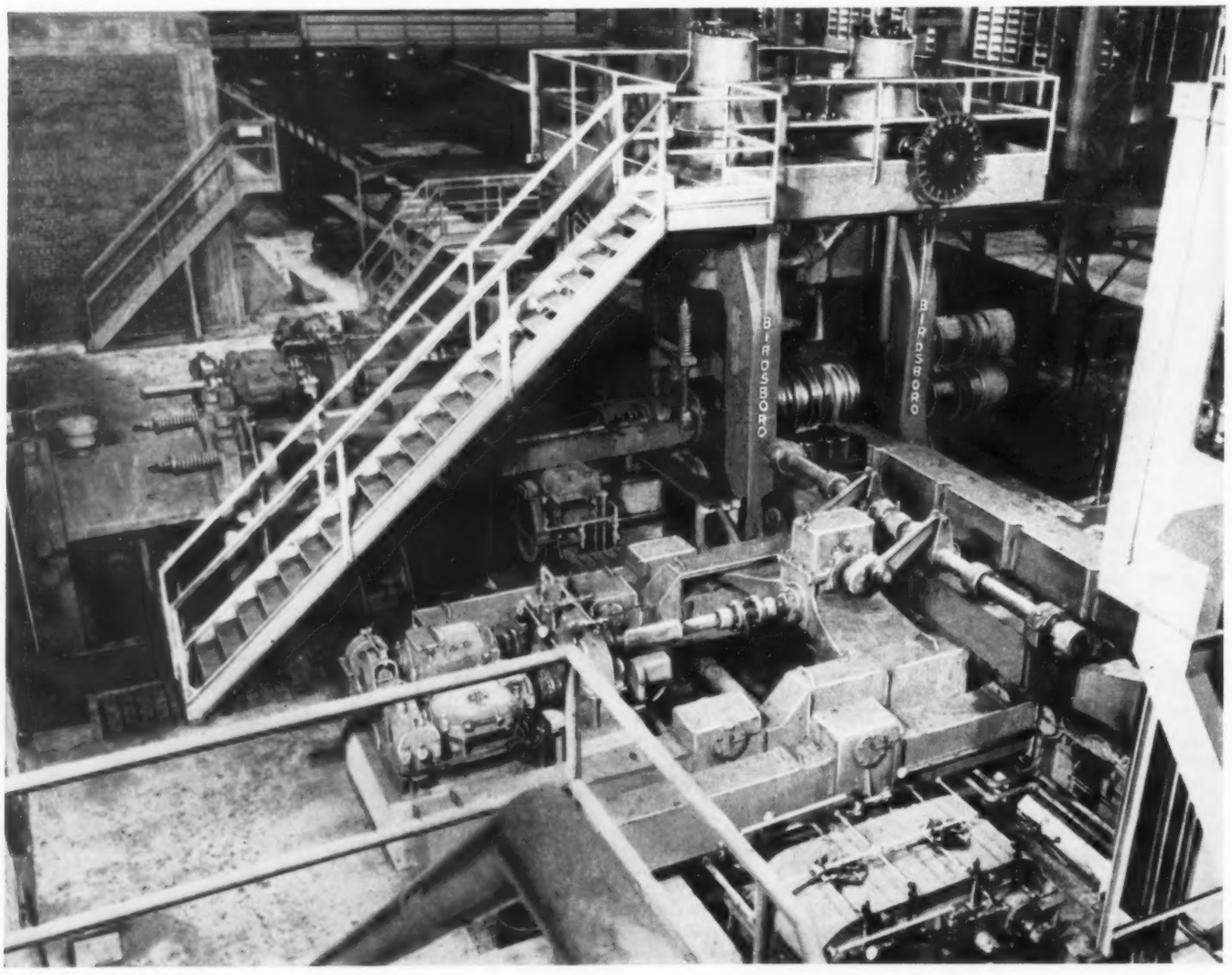
In Utah, **U. S. Steel's** *production horse (32" blooming mill) carries the famous* **BIRDSBORO** *brand*

In the New West, work horses are still being branded. Nowadays, the brand is no longer used to prevent rustling, but as a hallmark of pride.

In U.S. Steel's Geneva Works out in Utah, the BIRDSBORO brand rides high on the 32" blooming mill. Key installations throughout the world carry this name. It has come to represent more than machines, but ideas, too . . . ideas that have frequently helped pioneers of both East and West to advance the steel industry and its products ever forward.

Whether it be a single unit of equipment or a complete mill installation, BIRDSBORO's customized engineering can be a valuable tool in your expansion and modernization.

Ask for details of some of our recent projects that might have application in your plant, or call in the BIRDSBORO engineers for their appraisal of your own pioneering venture. *Sales Department, Engineering Department and Mfg. Plant:* Birdsboro, Pa., *District Office:* Pittsburgh, Pa.



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Agglomeration Tests Begin In New Grate-Kiln Pilot Plant

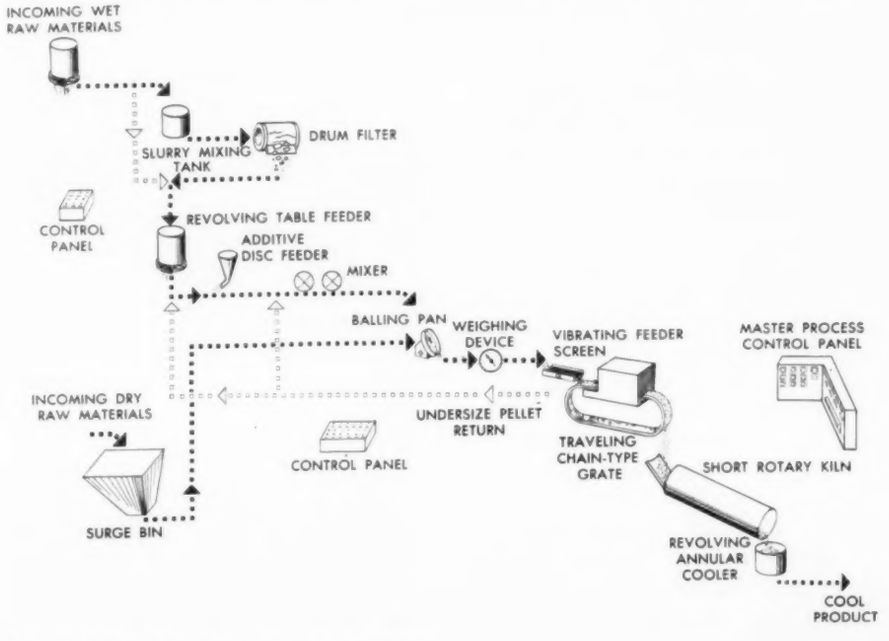
AS Allis-Chalmers new process pilot plant went on stream recently at Carrollville, Wis., it began to provide anxiously awaited answers to many problems regarding agglomeration, heat treating or processing of a wide range of raw materials. Magnetite and hematite concentrates, natural fine iron ores, silicious bauxite, magnesite, cement, phosphate ores, dolomite and limestone are among materials scheduled for intensive study and evaluation on both a process and economic basis.

To assure that answers to industry problems are as complete and accurate as possible, the A-C pilot plant has been designed as a model of efficiency and versatility, with operations carried out with the precision of any exacting research and test laboratory.

At the heart of the new facility, a completely instrumented model of the clean and efficient double-pass grate-kiln system is being used by development engineers for three major considerations:

1. To demonstrate the feasibility of agglomeration (pelletizing) processes for the wide range of raw materials.
2. To determine variations in operating conditions.
3. To develop and study techniques required for handling, preparing and processing the test materials.

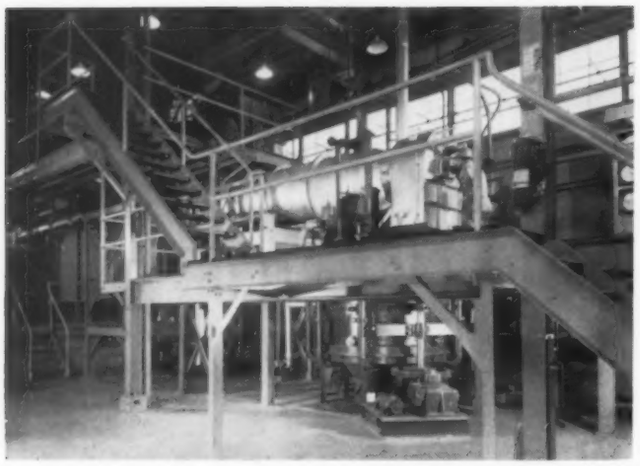
Figure 1 — This schematic of the Allis-Chalmers pilot plant illustrates three general ideas of operation: (1) alternate methods for handling raw materials such as wet concentrates, often metallics, or dry materials; (2) balling, weighing and sizing of raw materials; and (3) pyro-processes carried out in the efficient grate-kiln system, with subsequent product cooling and heat recovery.



SAMPLES FROM DIVERSE OPERATIONS

These intensive studies are conducted with multi-ton samples of minerals and ore concentrates sent Allis-Chalmers by various industries from operations throughout the Western hemisphere as well as parts of Europe and Asia. Making studies in $\frac{1}{50}$-scale equipment at Carrollville, prior to design and fabrication of commercial-size grate-kiln equipment, aids in optimizing design of system and components. Simultaneously, it helps predict operational information regarding full-scale, commercial plants.

For example, this facility is able to completely and flexibly duplicate full-scale materials handling; filtering and blending of wet raw materials; feeding of wet or dry raw materials; weighing; product cooling (heat recovery); proportioning of additives; and balling (pelletizing) the materials prior to processing in the combination of traveling chain



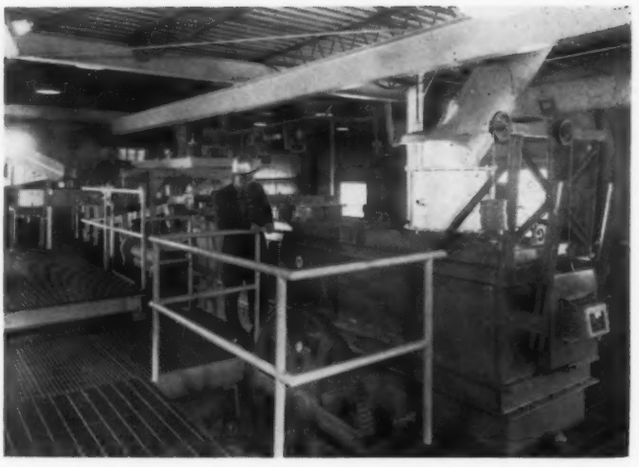


Figure 2 (left)—Over-all view of pyro-processing equipment shows the traveling chain type grate, top left, and rotary kiln used to predict full-scale production operating conditions. Annular cooler beneath kiln firing hood is used to cool system product and recover process heat. Grate-kiln system can be used to heat treat or agglomerate various metallic and nonmetallic minerals and concentrates.
Figure 3 (right) — Traveling grate section at pilot plant is divided into drying and preheating zones with respective wind boxes. As kiln exit gases pass through bed of pellets on the grate, dust is removed and pellets are preheated, contributing to system cleanliness and efficiency. Observations can be made and samples of partially processed pellets removed through the door on front of grate housing. Pellets are discharged from the grate into feed end of the rotary kiln below.

type grate and short rotary kiln. Extensive operational and process information is recorded for examination and interpretation by engineers of both Allis-Chalmers and the company seeking to process a material.

A-C invested $250,000 in this test and research facility. Commercial installations, along with promising information previously gained from a smaller pilot plant, have already pointed up the system's cleanliness, efficiency, economy and feasibility for a wide range of processes.

IRON ORE INDUSTRY

Work scheduled for iron ore agglomeration processes presently falls into three categories, all initially developed in the previous A-C pilot plant.

First, processes have been developed to agglomerate and heat treat magnetite and hematite concentrates produced from low-grade iron ore of almost unlimited availability. The product is extremely hard, durable pellets ideally suited for blast furnace feed. In addition, the processes offer the steel and ore mining industries important economies in fuel (approximately 750,000 Btu per net ton for magnetite), with operating and maintenance costs expected to be considerably below any other process achieving this excellent fuel efficiency. Pellet breakage during shipment between mine and blast furnace is virtually eliminated. These processes have been successfully demonstrated on a variety of ores from all parts of the United States, Canada and South America.

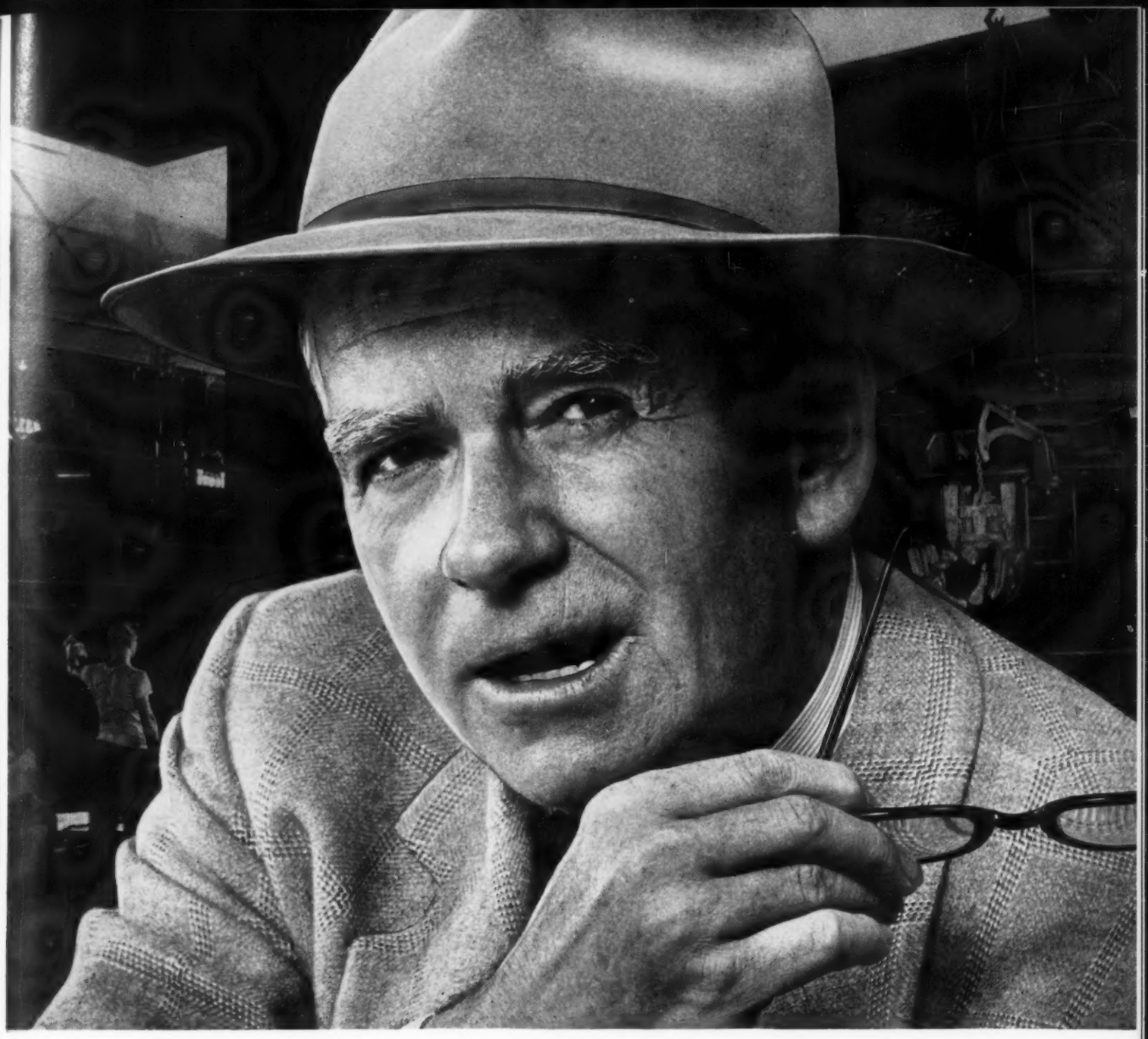
A second important consideration is the pelletizing of natural fine iron ores. Initial pilot plant work indicated that, with modification, the system can be used to carry out agglomeration processes for natural fine ores such as those found in Michigan and South America. As with the processing of magnetite and hematite concentrates, fuel efficiency, system economy and product superiority are attractive.

Finally, as more low-grade iron ore is used, magnetic roasting of hematite to magnetite with subsequent magnetic concentration increases in importance. To avoid vast expense in shipping unusable waste, low-grade ore, 20 to 40 per cent iron mixed with impurities in the form of aluminates and silicates, must be concentrated before loading into ore boats. After concentration, iron content will average 60 to 65 per cent compared with present "rich" natural ores of 50 to 52 per cent. Hematite is nonmagnetic, requiring a more elaborate "flotation" method of ore concentrating than magnetite. Indications are that it is feasible to roast certain types of hematite to magnetite, permitting the more economical method of magnetic concentration.

LIME AND DEADBURNED DOLOMITE

The combination of traveling grate and rotary kiln aids the process of lime production by calcination of limestone and the production of deadburned dolomite. Use of the grate section as an effective preheater and heat recovery device contributes to operating economy and substantially reduces dust loss over conventional process equipment. ▲

Figure 4 — Rotary kiln of A-C system completes heat treatment of the pellets preheated in the traveling grate. Processed kiln product is discharged from the bottom of the firing hood, near end, into the newly designed annular cooler beneath. Cooler recovers sensible heat from the product, contributing to system efficiency.



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Steel mill and foundry operators are cutting chromium costs by using the new ELECTROMET refined chrome for all high-carbon chromium additions. Inventory, handling, and storage are greatly simplified by stocking only this one high-carbon chromium alloy. It is ideal for use as:

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Refined chrome combines the economy of regular charge chrome with the maximum cleanliness and low residual element content of conventional high-carbon ferrochrome. For facts on how refined chrome can reduce your costs, contact your UNION CARBIDE METALS representative.

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O_2 Analyzer at Pittsburg, Cal. Works

Exclusive L&N Steam Jet Sampling System

New Trend in Open Hearth Combustion Control

Columbia-Geneva modernizes with continuous O_2 analysis

As fast as budget and operating conditions permit, open hearth furnace operators are switching to accurate, dependable Leeds & Northrup Oxygen Analyzing and Control Systems for improved O-H combustion practice. At over 70 installations, superintendents are anticipating increased roof life, lowered fuel costs and shorter heats.

Typical of complete installations of this industry-proved equipment are those at three plants of Columbia-Geneva Steel Division, United States Steel Corporation. There, 19 L&N systems have been in operation, some since early 1957, providing automatic control of exit gas O_2 content . . . speeding heats and lowering Btu requirements.

These systems operate directly from Leeds & Northrup Magnetic Oxygen Analyzers. Continuously sampling the oxygen content of waste gas, the Analyzers supply a signal to Speedomax® recorder-controllers. The control systems, in turn, operate to adjust louvers on the forced air fan, or control fuel directly to maintain the desired oxygen content in the waste gas.

And at all installations, the L&N Magnetic Oxygen Analyzing equipment is providing a stable, accurate measurement, fully compensated for background gases, without flammable auxiliary gases. The exclusive L&N Steam Jet Sampling feature assures that a clean sample is continuously delivered under pressure to the Analyzing Unit.

Ask your nearby L&N engineer about this important trend in open hearth combustion practice. He can give you facts and figures about how others have profited from this equipment. Call him, or write 4942 Stenton Avenue, Philadelphia 44, Pa.

LEEDS Instruments NORTHRUP Automatic Controls • Furnaces

Regulation of Blast Furnace Pressure Gives Increased Iron Production

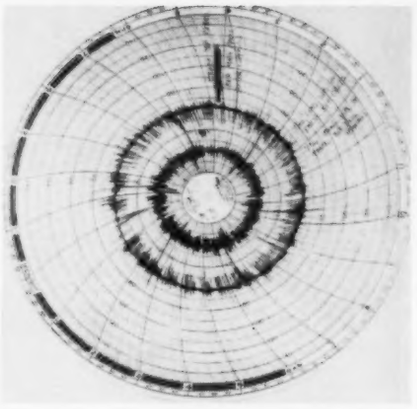


Figure 2 — Chart shows good pressure control.

AUTOMATIC regulation of blast furnace top pressure has resulted in increased iron production, without increasing flue dust loss, at several furnace installations, according to engineers of Hagan Chemicals & Controls, Inc.

The production gains are achieved by increasing the weight of gas per cubic foot within the furnace, thus permitting more oxygen to come in contact with the burden. Increased gas pressure is preferable to higher velocity, since the latter results in the loss of more burden particles as flue dust.

Figure 1 illustrates a typical Hagan top pressure control system installed at Alan Wood Steel Co., Conshohocken, Pa. Existing butterfly valves are used in parallel lines. The 30-in. valve gives good regulating characteristics, but has insufficient capacity to handle the requirements of the system. The 54-in.-valve is necessary to provide the excess capacity to handle system gas, as well as to provide a system bias or "dump" if necessary.

The automatic control system ratios the movement of the 54-in. valve to that of the 30-in. valve to provide stable control as well as required capacity. Remote bias or "dump" is also provided.

Top pressure control systems often require operation of existing butterfly valves, as in this case. Usually, these are oversized (full-line size) and provide extremely poor regulating characteristics. For this reason, the valve positioners have been characterized in the field to overcome these conditions. The valve operators provide a high ratio of power available to power required in order to obtain high-speed valve operation and suitable positioning accuracy.

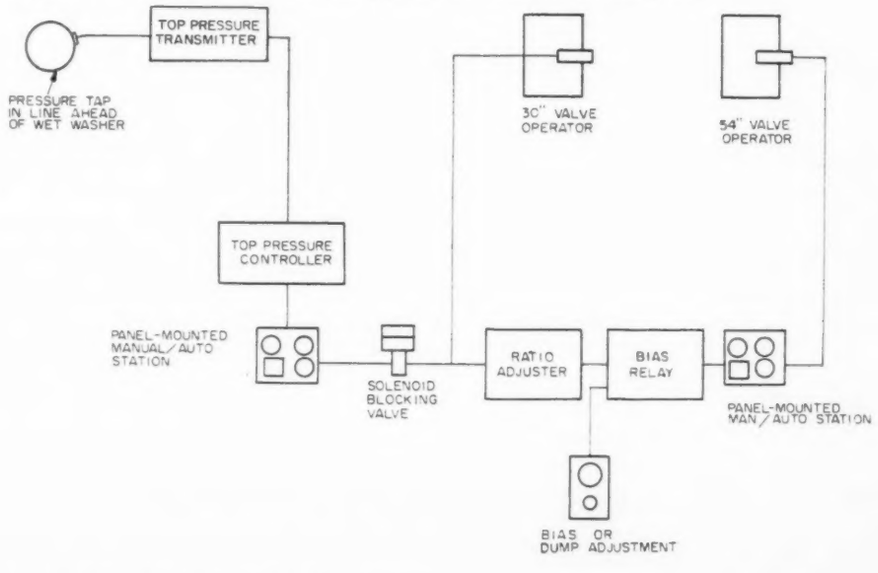
A recording of top pressure will normally show the extreme effects which the movement of the charging bells exerts on the blast furnace gas header system. The high volume change due to the movement of the charging bells will normally cause the control to drive the regulating valves toward the closed position (to maintain pressure set point), resulting in a momentary pressure surge when the bells reseat. The effect of these surges is to cause a tightening of the furnace burden and the resultant difficulties in maintaining production and a smoothly operating furnace.

In this system, this effect is overcome by use of a blocking valve operated automatically from a limit switch (or other suitable contact), indicating charging bell movement. This action holds the valve position until the bells reseat, thus minimizing resultant pressure surges.

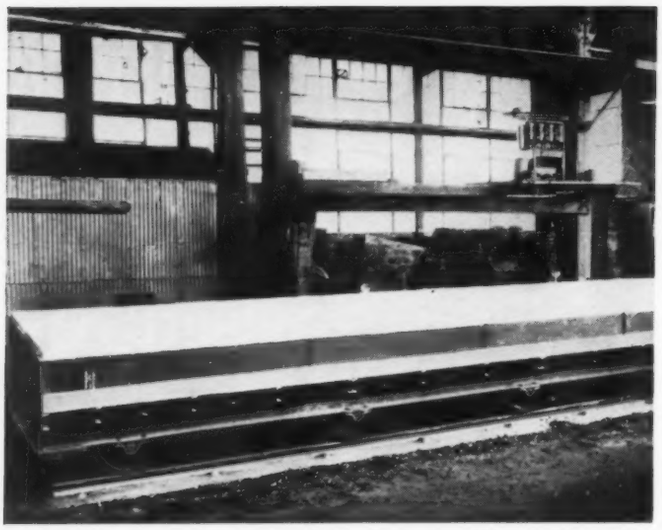
While this effect decreases as the ratio of the blast furnace gas line volume increases in relation to the volume change due to bell movement, this feature is desirable to include in these systems.

Figure 2 indicates blast furnace gas pressures at this furnace. The outside line is the pressure under control. It is taken ahead of the wet washers and ahead of the butterfly control valves. The inside line is the blast furnace gas pressure after the regulating valve as it is delivered to the boilers and other areas. ▲

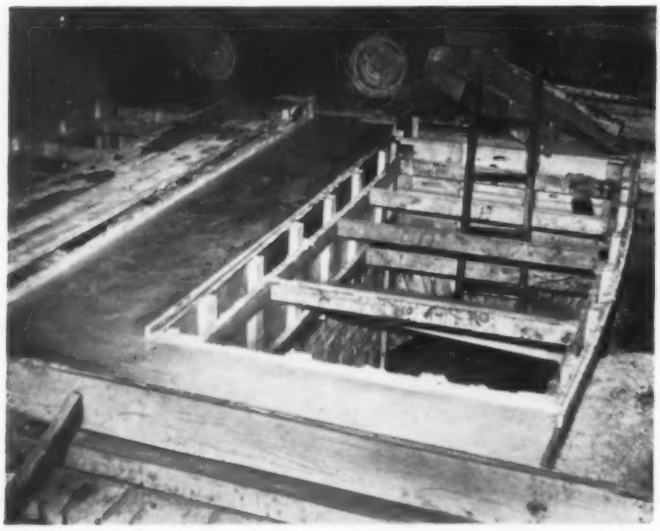
Figure 1 — Top pressure control system at Alan Wood Steel Co.



In this stress-relieving furnace, B&W Kaocrete-D is used on the floor ledges, car top, in the door jamb and at the end of the flat roof where it withstands the abrasion of the door. This material is specially designed to withstand severe abrasive conditions and mechanical abuse.



Heavy duty car top service requires a high strength castable. B&W Kaocrete-D is excellently suited for this service at temperatures to 2500 F. B&W Kaocrete-32 is recommended for service above this range.



B&W Kaocrete-32 has been cast to form the curb walls of a soaking pit. When mechanical abuse from ingots damages the curb, Kaocrete-32 has the necessary properties to localize the damage, thus maintaining the serviceability of the rest of the curb.

The castable lining of this aluminum reverberatory furnace must have unusually high strength to withstand the considerable physical abuse of charging, operating and cleaning, while resisting the penetration of the molten metal. Kaocrete-D is widely used in this application.

How B&W refractory castables solve abrasion problems

Refractory castable linings used in metal-working furnaces are often subjected to severe mechanical abuse. Scraping by hand tools, loading and unloading, and the action of the molten metal and particle-laden gases all affect the life of refractories. Among B&W's line of refractory castables are two that are particularly suited to withstand unusual abrasive conditions. They are B&W Kaocrete-D and B&W Kaocrete-32, both of which have been used successfully in many demanding applications.

B&W Bulletin R-35A gives additional information on versatile B&W refractory castables. Write for copy to The Babcock & Wilcox Company, 161 East 42nd Street, New York 17, N.Y.

R606R

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REFRACTORIES DIVISION

B&W Firebrick, Insulating Firebrick, and Refractory Castables, Plastics, Ramming Mixes, Mortars, and Ceramic Fiber.

Date-line Diary...

September 1

△ Dept. of Commerce, Bureau of the Census reports that June, 1959, shipments of nonferrous castings totaled 206,464,000 lb compared with 211,752,000 lb in May, 1959.

September 2

△ American Iron Ore Assn. reports shipments of iron ore down Lake Superior totaled 797,979 gross tons in August, 1959, compared with 9,324,061 gross tons in August, 1958.

△ Federal Reserve Board reported that consumer instalment credit in July, 1959, amounted to more than $36,400,000,000, a seasonally-adjusted increase of approximately $500,000,000; total consumer credit, instalment and noninstalment, rose to $47,300,000,000, a seasonally-adjusted increase of $647,000,000.

△ According to the National Tool Builders Assn., machine tool orders in July, 1959, were estimated at $63,450,000, down nearly $2,000,000 from June, 1959.

September 3

△ Dept. of Commerce, Iron and Steel Div., reports that world steel production, exclusive of Communist China and North Korea, in the first six months of 1959, reached an annual rate of 346,000,000 tons, compared with 289,000,000 tons produced in 1958 and 316,000,000 tons produced in 1957. Major part of the recovery is accounted for by increase in U. S. production, which totaled 64,300,000 tons; substantial production increases were noted in Canada, Japan and U.S.S.R.

September 4

△ AISI reports that imports of steel mill products in June, 1959, totaled 410,005 net tons compared with 384,787 net tons in May, 1959, and 126,408 net tons in June 1958; exports for these periods amounted to 191,355 net tons in June, 1959, compared with 165,856 net tons in May, 1959, and 163,309 net tons in June, 1958.

△ The Bureau of Mines reported that production of Pennsylvania anthracite for August, 1959, was 1,498,000 net tons, compared with 1,142,000 net tons in July, 1959, and 1,750,000 net tons in August, 1958.

September 5

△ The Aluminum Assn. reported that shipments of aluminum sheet and plate in July, 1959, totaled 173,129,000 lb, compared with 162,915,000 lb in June, 1959. Shipments of aluminum foil in July, 1959, totaled 24,807,173 lb compared with 21,864,879 lb in June, 1959.

September 8

△ The AISI reports that the operating rate of the steel industry for the week of Sept. 7, is scheduled at 337,000 tons (11.9 per cent of capacity). This compares with 332,000 tons one week ago (11.7 per cent capacity), and 1,780,000 tons one year ago. Index of production for the week is 21.0.

△ U. S. Dept. of Commerce, Bureau of the Census, reported that shipments of iron and steel castings in June, 1959, amounted to 1,481,137 short tons compared with 1,455,081 tons in May, 1959, and 1,012,691 tons in June, 1958.

△ New cars sales in August, 1959, totaled 485,000 U. S.-built units, which was 7 per cent over July, 1959, and 50 per cent over August, 1958, sales. Inventories on Sept. 1, amounted to 725,000 cars compared with 965,000 total on August 1, 1959.

September 9

△ Fiscal report for Keystone Steel & Wire shows for the year ended June 30, net sales amounted to $120,071,295, net income $9,075,374 or $4.84 per share, compared with sales amounting to $97,706,805, net income of $5,984,595 or $3.19 per share for the year ended June 30, 1958.

△ Copper prices were increased 1½¢ a lb to 31½¢ by Anaconda and some other operating facilities not affected by the strike. Amercan Metal Climax, Ltd. the only major custom smelter still operating, increased price 3¢ to 33¢ per lb.

September 11

△ Discount rates, effective today, at eight Federal Reserve Banks, will be 4 per cent, up ½ per cent.

△ Government reports show that expenditures for new plant and equipment this year are now projected at $33,300,000,000, an increase of $700,000,000 from the three-month ago estimates, and reflects an increase of 9 per cent above 1958 outlays for this purpose.

September 14

△ The AISI reports that the operating rate of the steel industry for the week of Sept. 14, is scheduled at 345,000 tons (12.2 per cent of capacity). This compares with 327,000 tons one week ago (11.5 per cent capacity), and 1,771,000 tons one year ago. Index of production for the week is 21.5.

September 16

△ Quebec Cartier Mining Co. has completed arrangements with a group of American and Canadian banks for the establishment of credit enabling them to borrow up to $200,000,000 in U. S. dollars between now and Dec. 30, 1960, to be used to develop the project to mine iron ore in the Lac Jeannine area.

September 17

△ The Government reported that the seasonally adjusted rate of personal income receipts fell to $381,400,000,000 annually in August, 1959, $2,600,000,000 below the July, 1959, pace.

September 18

△ Border Steel Rolling Mills, El Paso, Texas, registered with the SEC for $2,100,000 of subordinated debentures, due 1974, and 210,000 shares of common stock. Company plans to build a merchant bar and rod mill, an electric melt shop with annual capacity of 48,000 tons.

September 21

△ The ARCI reported that deliveries of new freight cars in August, 1959, totaled 4890 compared with 4273 in July, 1959, and 2151 in August, 1958. New orders for August, 1959, amounted to 1753 cars compared with 4159 in July, 1959, and 1773 in August, 1958. Backlog of cars on order as of September 1, 1959, was 37,172 compared with 40,309 on August 1, 1959, and 25,611 on September 1, 1958.

Δ The Labor Dept. reported that workers drawing unemployment compensation in the week of September 5, dropped 32,500; in the week ended September 12, new claims totaled 187,800 a drop of 49,500.

Δ Alan Wood Steel Co. has called a special stockholders meeting for October 8, to request shareholders to eliminate restrictions on the amount of long-term debt the company can incur to get ready for a major financing program currently under active study.

Δ Northwestern Steel and Wire Co. reports for the fiscal year ended July 31, 1959, sales totaling $83,781,-108, net profit $8,450,321 or $3.38 per share of common stock compared with sales totaling $60,468,595, net profit of $5,049,890 or $2.02 per common share for the fiscal year ended July 31, 1958.

Δ The Industrial Heating Equipment Assn. reported that new orders for industrial furnaces in August, 1959, were $9,738,000, compared with $3,533,000 in August, 1958. New orders for induction heating equipment in August, 1959, totaled $1,283,000 compared with $383,000 in August, 1958.

Δ The AISI reports that the operating rate of the steel industry for the week of September 21, is scheduled at 359,000 tons (12.7 per cent of capacity). This compares with 356,000 tons one week ago (12.6 per cent capacity), and 1,816,000 tons one year ago. Index of production for the week is 22.3.

September 22

Δ Jessop Steel Co. Inc., Washington, Pa., announced it purchased Chase Steel & Supply Co., of Los Angeles, a warehouser of stainless steel productions; the transaction involved nearly $1,750,000, about half in cash and the remainder in treasury stock.

Δ Railroads presented a proposal to 11 unions representing approximately 550,000 workers including clerks, telegraphers and station agents, asking acceptances of a 15-cent hourly wage cut; these non-operating unions had presented demands for a 25-cent hourly wage boost and increased fringe benefits. Agreement for a moratorium on changes in wage rates expires October 31.

Δ Major producers increased price of zinc by 1¢ to 12¢ per lb in East St. Louis.

Δ Bureau of the Census, Industry Div., reports that production of titanium ingots for July, 1959, totaled 641,460 lb compared with 1,290,319 lb in June, 1959; production of titanium mill products in July, 1959, totaled 362,860 lb compared with 621,614 lb in June, 1959.

Δ Bureau of the Census, Industry Div., reports that shipments of commercial steel forgings in July, 1959, totaled 103,000 short tons, 27 per cent below June, 1959, shipments but 52 per cent over shipments in July, 1958. Backlog of orders for commercial steel forgings at July, 31, totaled 377,000 short tons, one per cent above June 30, 1959, and 46 per cent over July 31, 1958.

September 23

Δ Bureau of the Census, Industry Div., reports that July shipments of nonferrous castings totaled 177,-197,000 lb, compared with 206,820,000 lb in June 1959.

September 24

Δ The Securities and Exchange Commission reported individual indebtedness rose to $157,900,000,000, up $5,900,000,000 in the second quarter of 1959; gross savings amounted to $8,300,000,000, a gain of $2,400,-000,000 in the same period.

Δ The Aluminum Assn. reported that primary aluminum production in the United States during August, 1959, was 172,817 short tons compared with 179,194 short tons in July, 1959, and 125,416 short tons in August, 1958.

September 25

Δ Budget Director Stans presented figures placing Government revenues in the year ending June 30, 1960, at $79,000,000,000, $100,000,000 above estimated expenditures, but warned this could be turned into a deficit if the steel mill shutdowns continue.

Δ Resistance Welder Manufacturers' Assn. report that new orders during August amounted to more than $2,250,000 an increase of 17 per cent over July, 1959; a backlog of nearly $7,125,000 were reported.

Δ The AISC reported that bookings of fabricated steel in August, 1959, totaled 196,985 tons compared with 259,131 tons in July, 1959, and 225,768 tons in August, 1958; shipments in August, 1959, amounted to 220,420 tons compared with 238,559 tons in July, 1959, and 298,012 tons in August, 1958. Backlog of future work as of August 30 totaled, 1,771,883 tons.

September 28

Δ Retail deliveries of automobiles for the month of September, 1959, totaled 350,000 cars, 37 per cent above September, 1958.

Δ F. W. Dodge Corp. reports that construction contracts in the United States in August, 1959, totaled $3,083,649,000, 11 per cent below August, 1958.

Δ The AISI reported that blast furnace production during August, 1959, amounted to 947,779 net tons of pig iron and ferroalloys compared with 3,573,550 net tons in July, 1959, and 4,799,955 tons in August, 1958. August, 1959, steel production (revised) totaled 1,439,277 net tons of ingots and steel for castings.

Δ The AISI reported that the operating rate of the steel industry for the week of September 28, is scheduled at 365,000 tons (12.9 per cent of capacity). This compares with 362,000 tons one week ago (12.8 per cent capacity), and 1,901,000 tons one year ago. Index of production for the week is 22.7.

Δ A. M. Byers stockholders approved a 3-for-1 split on the firm's common stock, as well as a stock option plan for key employees. The board of directors declared a regular quarterly dividend of 5¢ on the new split common stock, payable October 30, for stock on record October 15; a year-end extra of 15¢ per share was declared payable November 30, for stock on record November 13, 1959; and the regular $1.75 dividend of $1.75 on the preferred stock, payable October 30, for stock on record October 9, 1959. The board of directors also authorized a voluntary exchange offer to the holders of 7 per cent cumulative preferred stock who may receive a 7 per cent debenture in the principal amount of $100 and one share of the new split common stock for each share of preferred stock.

September 29

Δ President Eisenhower summoned industry and union leaders to meet with him separately at the White House in a last-chance effort for settlement of the 77-day-old steel strike.

September 30

Δ Carpenter Steel declares 100 per cent common stock payment to effect a 2-for-1 split of outstanding common shares. Distribution will be made October 30, to shareholders of record October 13, 1959.

Δ President Eisenhower set a deadline of October 8, for settlement of the steel strike.

WAGNER
Integral-Type Gearmotors

Wagner Integral-Type Gearmotor with TEFC motor. Standard or explosion-proof.

Wagner Integral-Type Gearmotor with open protected motor.

For the Power you want - At the Speed you need !

Wherever you need "slower than motor speeds" you can get positive speed reduction with plenty of power by using Wagner Gearmotors.

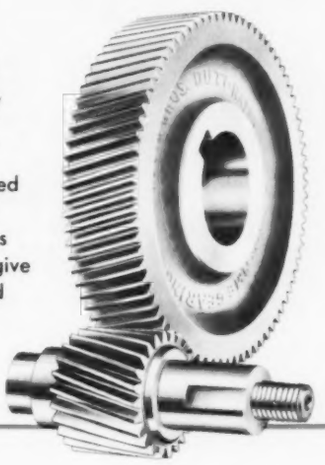
This extension to the Wagner line provides compact motorized drives, with both motor and gear housing of corrosion-resistant cast iron. Available with the latest NEMA Frame open protected or totally enclosed fan-cooled motors, they combine Wagner motor dependability with rugged, simplified gear units to give you speed reduction equipment designed for greater capacity and longer life in ordinary up to rough service.

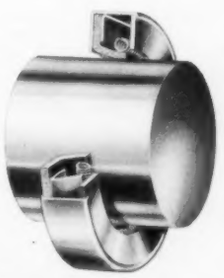
Wagner Gearmotors offer a wide variety of sizes in single, double, triple or quadruple reductions—horizontal or vertical foot or flange mountings—speeds from 7½ to 780 RPM. Write for Bulletin MU-227.

Whether you specify or apply power transmission equipment, your nearby Wagner Sales Engineer will be glad to help you select the right drive for your applications. There are Wagner Branches in 32 principal cities.

Heat treated high capacity helical gears

Gears are hardened after cutting, for maximum hardness and accuracy, to give extra capacity and longer wear life.





Positive Oil Seals

Improved lip type seals are used on horizontal shafts. On vertical output shafts, double mechanical seal with slinger and drain-off gives positive protection against leakage.

Wagner Electric Corporation

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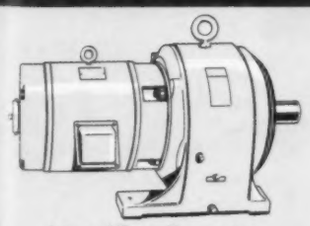
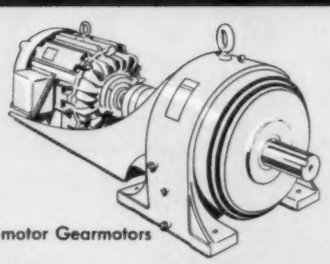
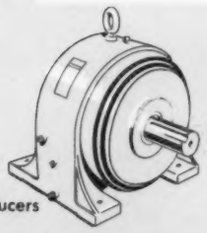
WAGNER SPEED REDUCTION EQUIPMENT



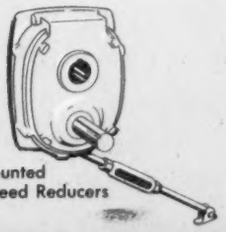
Integral-Type Gearmotors



All-motor Gearmotors

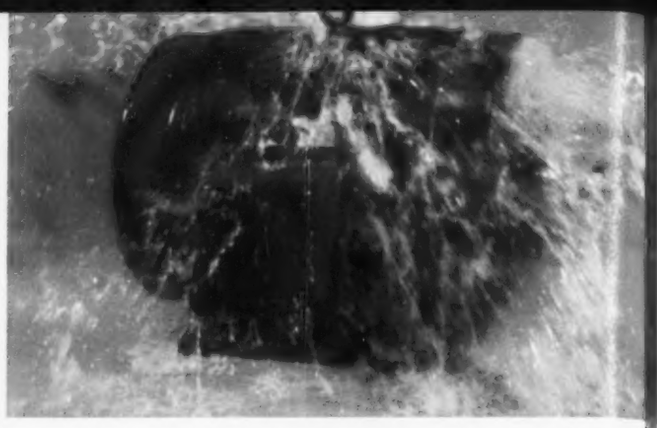


Speed Reducers



Shaft-mounted Speed Reducers

DOUBLY PROTECTED. Air intakes and outlets protect against falling or splashing liquids. Cast iron frames protect against rough handling and corrosion.



TYPE DP · Doubly Protected against corrosion · against falling or splashing liquids

These motors give the double protection of corrosion-resistant cast iron frames and dripproof enclosures that are so well designed that they can be used in many applications that formerly required splashproof motors. Available with ball bearings, or with high load carrying capacity sleeve bearings for extra quiet operation. Write for Bulletin MU-223.

1 TO 125 HORSEPOWER – 1750 RPM – 40° C – NEMA FRAMES 182 THROUGH 445U

You get less downtime, lower upkeep, with WAGNER PROTECTED-TYPE MOTORS

If you need motors that will keep production rates up . . . that will give you the continuity of service you want . . . that will operate with complete dependability under the most severe conditions in their specific applications—use Wagner Protected-Type Motors. These motors pack extra power into little space, are light in weight, and are easy to maintain.

Let your Wagner Sales Engineer show you how these protected motors can bring you savings in initial motor costs, maintenance costs, and in continuity of operation.

Wagner Electric Corporation
6400 PLYMOUTH AVENUE, ST. LOUIS 14, MO., U. S. A.

WM59-10

1 TO 100 HORSEPOWER – 4 POLE – 60 CYCLE – NEMA FRAMES 182 THROUGH 445U

TYPE EP · Extra Protected against corrosive or abrasive elements

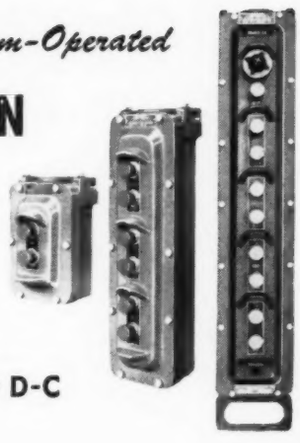
Wagner Type EP Motors are totally-enclosed, fan-cooled—for complete protection against dust, abrasives, fumes, steel chips or filings. Type JP is explosion proof as well—designed and approved for use in explosive atmospheres. Cast iron frames protect against corrosion and ribs on the frames add mechanical strength and increase the surface cooling area. Effective cooling system adds to motor life. Write for Bulletin MU-224.

SECURELY SEALED FOR LOW MAINTENANCE. Both ends of these motors have running shaft seals to keep the heavy duty bearings clean. Bearing housings are effectively sealed to prevent escape of grease. Openings are provided to permit relubrication that adds years to motor life under severe conditions.

For Hazardous Locations

Heavy-Duty, Cam-Operated

PUSH-BUTTON STATIONS



600 Volts
A-C or D-C

● The Euclid Electric & Mfg. Co. (Madison, Ohio) has added a complete new line of Pendant Push-Button Stations for all applications that necessitate NEMA Types 7 and 9 enclosures to meet hazardous-location requirements. Designed for heavy-duty applications, these cam-operated Stations are rated 600 volts, a-c or d-c. They are available from one to five speed-points in each direction for a total of eight circuits to provide for practically an unlimited number of different sequences of operation.

Sturdily constructed to withstand hard usage and abuse, their small cross-section permits comfortable, non-fatiguing, one-hand operation. Where required, a bottom holding handle can be supplied. The dense cast-aluminum enclosure can be readily opened for inspection of the silver-to silver contacts without disturbing any wiring. The conduit hole is threaded and a double-suspension cable hanger is provided.

Extra features include heavy-duty, control-circuit toggle disconnects, pilot lights, selector switches, and maintained-type contacts.

ASK FOR BULLETIN 2017

THE EUCLID ELECTRIC & MFG. CO.
MADISON, OHIO

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MANSAVER® GRABS

Handle Millions of Tons in Your Industry

From Packaging Line to Shipping

The 14 foot Mansaver shown here is working at the packaging line of a large steel plant, lifting two packages of 26 × 120 cold-rolled sheets weighing over seven tons. Supplied hand-operated, as shown, or motor-driven. Other models handle coils, tinplate, etc., paying for themselves with concrete savings in time and improved safety.

Whether for racks, sheets, coils, bars, or other products, the selection of the proper Mansaver Grab at the time you purchase a crane will appreciably reduce the cost of your entire installation. The proper grab will give you more storage in a given cubic space, reduce aisle widths, and get materials to and from storage and production lines quickly, safely, and with minimum effort.

CHECK THE ITEMS YOU HANDLE AND SEND FOR LITERATURE AND MORE COMPLETE INFORMATION

☐
SHEETS

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COILS

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BARS

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BILLETS

MANSAVER INDUSTRIES, INC.
3116 East St., New Haven, Conn.
Also Manufactured in England

NBD T-3 alloy kick-out screws cut rejects to a minimum at this transfer table

Now T-3 tests are setting new records in a wide range of hot guide and guide-roll applications.

Here's how it began. The continuous weld mills of Jones & Laughlin at Aliquippa had a problem to lick at the transfer table. Hot conduit shooting from the butt weld machine at 2000° F was building up hard scale on the iron kick-out screws—just enough to scratch and mar the tubing.

Aliquippa demanded constant top quality in the conduit they shipped . . . and that meant high rejection rates at the mills. An NBD Sales Engineer came up with a solution . . . based on NBD experience in a *glass factory!*

NBD had previously developed a special bronze mold alloy for the glass-container industry . . . one that would not stick to glass and would take all the thermal and mechanical shock of high-speed, high-temperature, glass-making operations.

Would the alloy work with steel?

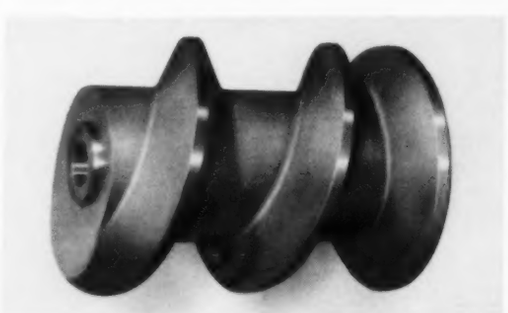
J & L personnel at the Aliquippa works decided it was worth a try . . . and ordered a trial set of kick-out screws made of the alloy for test in the No. 1 mill.

The alloy was NBD T-3 . . . and it worked perfectly with steel! No more surface marring of conduit. No more scale build-up. Kick-out screws actually tended to self-polish, giving a smoother performance with each pass. They lasted longer, showed less wear, cut costly maintenance and replacement to a minimum.

Today, T-3 alloy kick-out screws are in successful operation in both No. 1 and No. 2 mills at Aliquippa . . . helping to keep quality of conduit up, rejects down!

NBD alloy T-3 may be the answer to cost reductions in your plant . . . for entry guides, delivery guides, angle guides, roller guides, planishing rolls, tube-forming rolls and such.

Call in your nearby NBD Sales Engineer for a talk about T-3. Or send us an outline of your needs to NBD, 717-E Grant Building, Pittsburgh 19, Pennsylvania.



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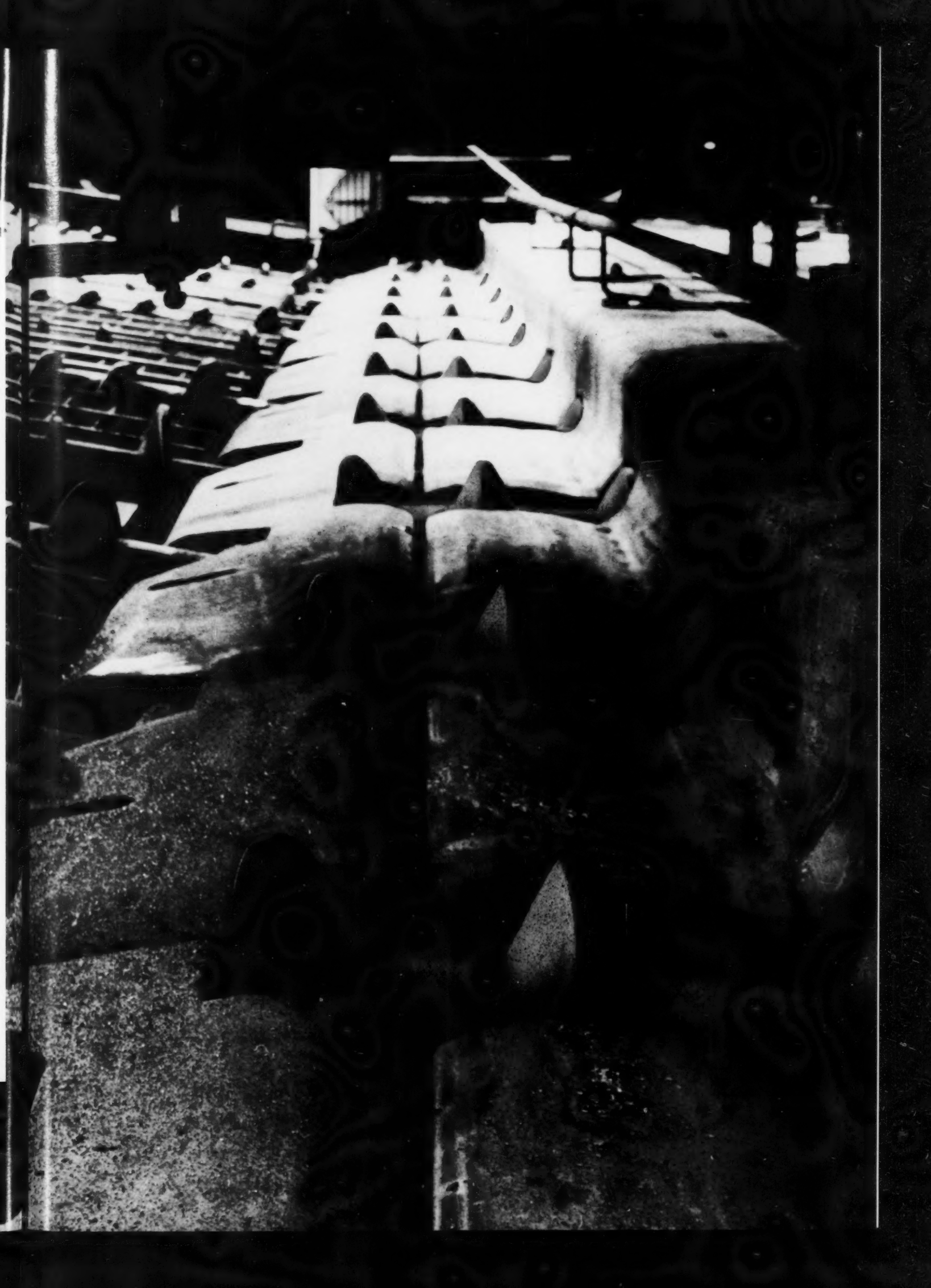
PLANTS IN: CHICAGO • ST. LOUIS • MEADVILLE, PA.



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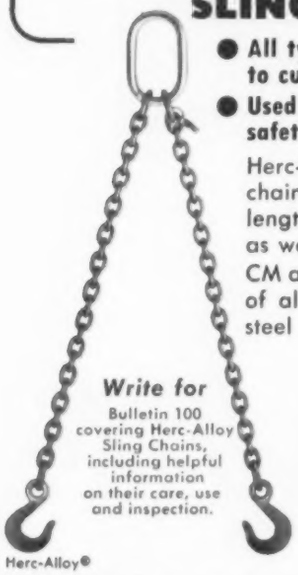
SLING CHAINS

- **All types and sizes assembled to customers' specifications.**
- **Used throughout industry where safety is paramount.**

Herc-Alloy is the original alloy chain. It is available in running lengths and special assemblies as well as slings.

CM also produces welded chain of all types including stainless steel and bronze.



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We offer forty years of experience in producing the highest quality Metal Cutting Knives and skilled craftsmen working with the finest materials to exacting tolerances.

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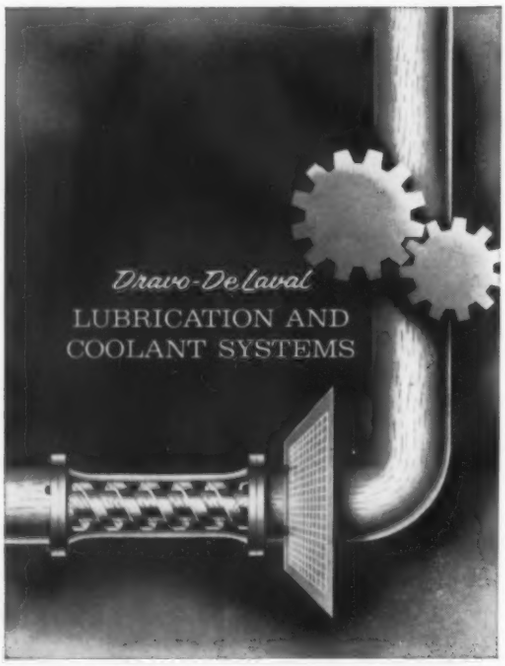
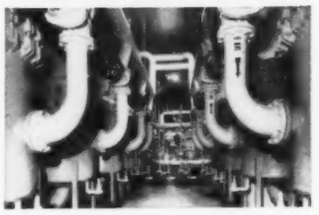
LUBRICATION *and* COOLANT SYSTEMS



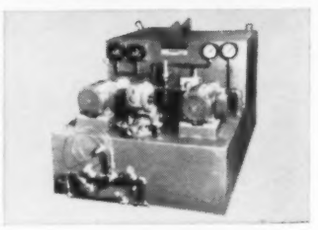
AVAILABLE NOW. New brochure discusses the full line of Dravo-DeLaval Lubrication and Coolant Systems. Address your request for Bulletin No. 1451 to Mill Lubrication, Dravo Building, Pittsburgh 22, Pa.

LUBRICATION SYSTEMS
Engineered to meet your precise needs, a Dravo-DeLaval system is designed for economy of operation. Maintenance is easy, and costly machinery is protected by precision lubrication; temperatures and pressures are held at optimum values.

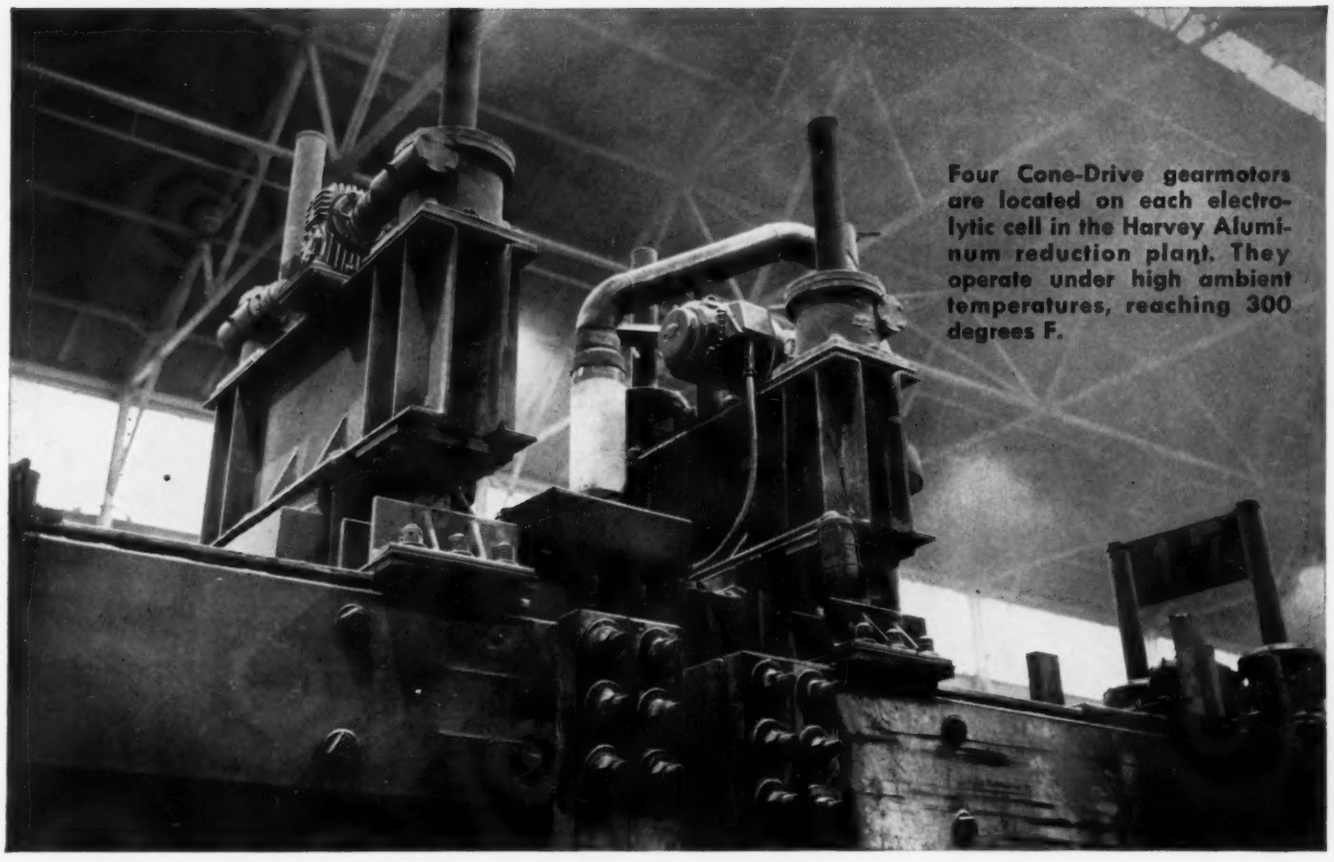
COOLANT SYSTEMS
Custom engineering involves every system component, from oil reservoirs to the full automatic controls. These coolant systems are designed for hot and cold rolling of ferrous and non-ferrous metals, such as aluminum strip and foil.



UNILUBE SYSTEMS
Designed to provide economical, full pressure feed lubrication, the Unilube is a prefabricated "package" which offers all the advantages of the larger custom designs. Capacities range from 1 gpm to 75 gpm over the full range of viscosities.

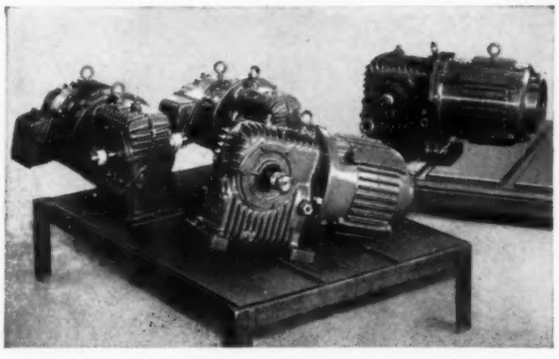


DRAVO
CORPORATION



Four Cone-Drive gearmotors are located on each electrolytic cell in the Harvey Aluminum reduction plant. They operate under high ambient temperatures, reaching 300 degrees F.

AT HARVEY ALUMINUM . . .
100,000,000-lb yearly capacity using 1,000 Cone-Drive gearmotors



Four double-enveloping worm gearmotors used by Harvey Aluminum are shown here after test run in Cone-Drive plant. They were palletized in groups of four for shipment to Oregon smelter.

From its modern reduction plant at The Dalles, Oregon, Harvey ships primary aluminum in pig, ingot and billet forms all over America. The smelter includes the latest and most efficient equipment and operating techniques. Reflecting this modern equipment are 1,000 Cone-Drive double-enveloping worm gearmotors, used to control the height of anodes and casings in relation to the molten aluminum bath in each of the electric furnaces. Annual capacity is more than 100-million pounds.

The gearmotors are operated under high ambient temperatures that reach 300° F. This was an important consideration in Harvey's selection of Cone-Drive gearmotors. In addition, the ability to withstand the full force of stalled driving motors and constant reversing operations figured in Cone-Drive gearing's selection.

Cone-Drive double-enveloping worm gearmotors are available in a wide variety of styles and sizes. Models include standard shaft or hollow shaft with worm over or under or gearshaft vertical. Capacities range from ¼ to 40 HP and reductions from 3.3:1 to 240:1. Ask for Catalog No. 58 for complete specifications.

CONE-DRIVE GEARS DIVISION MICHIGAN TOOL COMPANY

7171 E. McNichols Road • Detroit 12, Michigan • Telephone: TWinbrook 1-3111

DOUBLE-ENVELOPING WORM GEARSETS

DOUBLE-ENVELOPING WORM GEAR SPEED REDUCERS

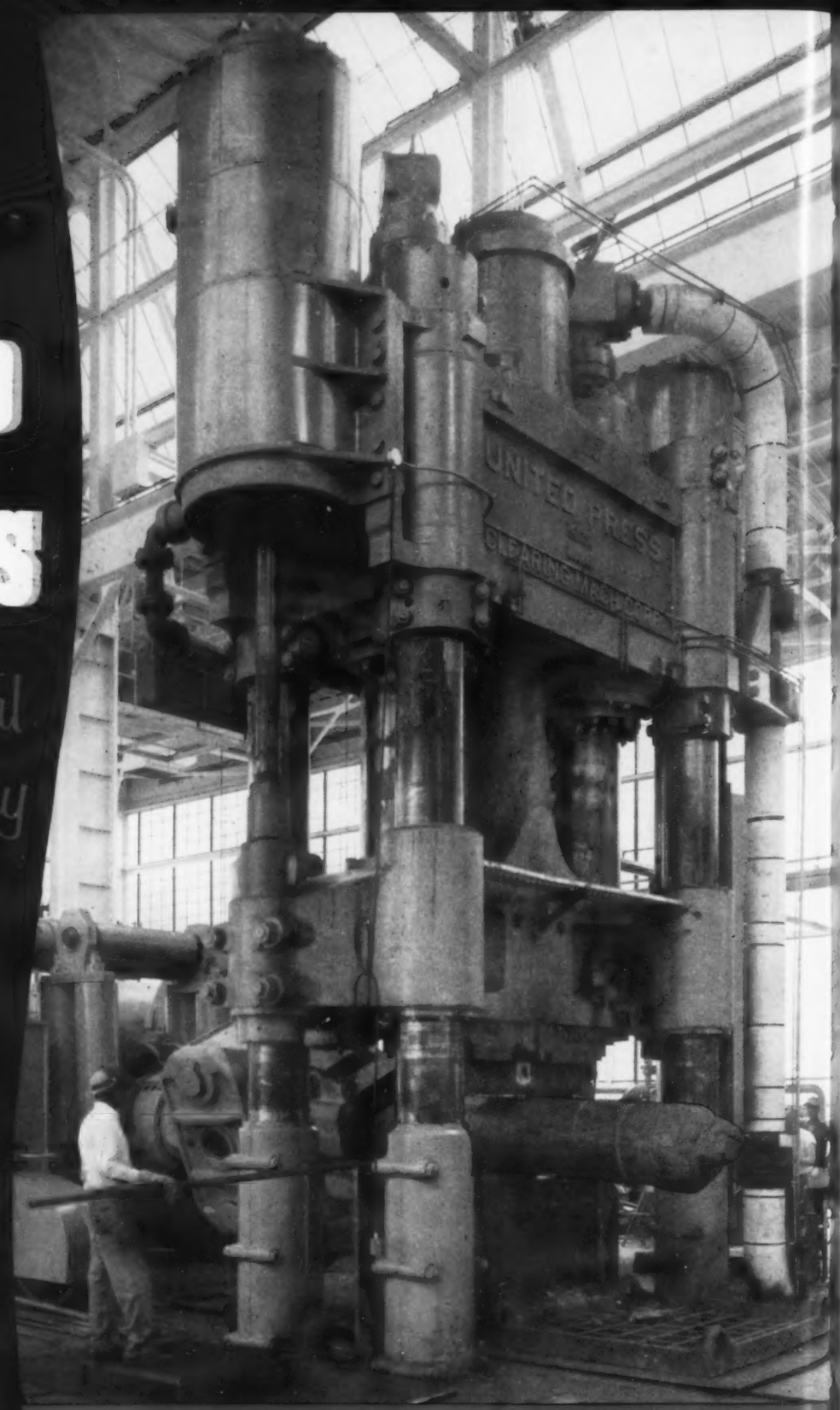
DOUBLE REDUCTION WORM GEAR SPEED REDUCERS

DOUBLE-ENVELOPING RIGHT ANGLE GEARMOTORS

Forging

Ohio Rolls

to shape metal for all Industry



. . . this 2,500 ton forging press, now in operation at the Lima plant, is the latest member of Ohio Steel's family of roll producing equipment.

The giant manipulator, overhead crane and banks of the latest in car type gas fired furnaces complete this new forging facility — A modern facility with which to produce Ohio Forged Steel Rolls.

The Ohio Steel Foundry Co.

LIMA, OHIO ... *Virtually at the center of the steel industry*

PLANTS AT LIMA AND SPRINGFIELD, OHIO

OR32

OHIO IRON AND STEEL ROLLS

Carbon Steel Rolls
Ohioloy Rolls
Ohioloy "K" Rolls
Nioloy Rolls
Flintuff Rolls
Double-Pour Rolls
Chilled Iron Rolls
Forged Steel Rolls
Denso Iron Rolls
Nickel Grain Rolls
Special Iron Rolls

Industry News...

CONNORS STEEL BEGINS EXPANSION PROGRAM

△ A major increase in steelmaking capacity will result from new construction plans for the West Virginia Works of Connors Steel Division, H. K. Porter Co., Inc.

J. H. Girdler, manager of the West Virginia Works, said that a $1,600,000 expansion program would begin immediately.

"Target date for completion is June 1, 1960. The present furnace building will be expanded eastward and westward on property already owned by the West Virginia Works," he said.

The specific plans as outlined by Mr. Girdler call for addition of some 7200 sq ft to the present furnace building.

Expansion details include: Installation of new electric furnace and two additional ingot soaking pits; erection of a craneway to carry a new 30-ton crane for more effective materials handling; and the enlargement of present furnace building services and facilities to accommodate the new equipment.

A two million dollar program which modernized the plant's 12-in. rolling mill and increased rolling capacity by more than fifty per cent was completed in 1958.

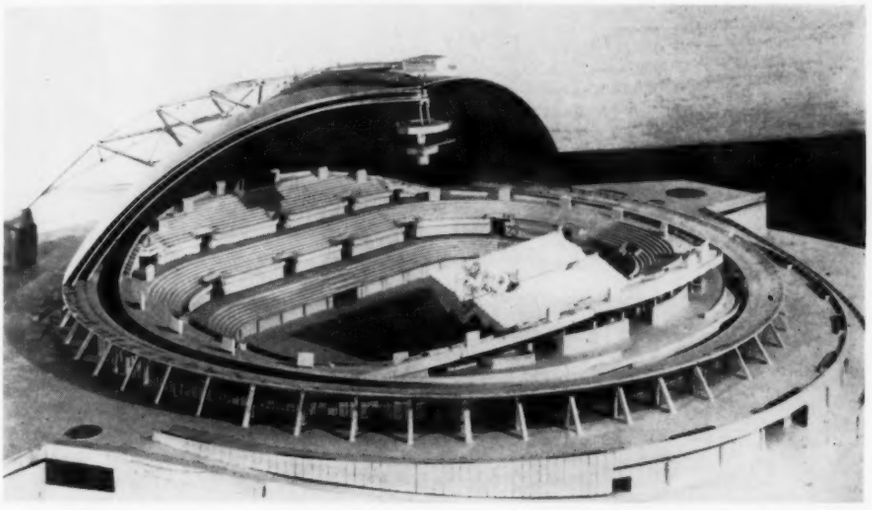
WORK TO BEGIN SOON ON RESEARCH CENTER

△ Construction will begin in about two months on National Steel Corp.'s giant new Research and Development Center at Weirton, W. Va.

The new all-steel building will be located in the Weirton Heights area and present plans call for construction to be completed about one year from the time work is started.

When the Research Center is completed, its activities will be carried on under the supervision of J. H. Strassburger, vice president of Research and Development for National Steel and Dr. Ivor E. Campbell, director of Research and Development.

GIANT RETRACTABLE DOME TO FEATURE STAINLESS



The Public Auditorium of Pittsburgh and Allegheny County is shown here in a scale model. The unique auditorium designed for major sports events, symphonies and other civic events, will have the largest retractable stainless steel dome in the world and is scheduled for completion in 1961.

While the initial installation will contain approximately 50,000 sq ft of space, Mr. Strassburger pointed out that the center can be expanded to five times its original size as the search for new products and processes continues in the future.

The new two-story structure will be of modern design with a colorful porcelain enamel panelwall exterior. Half the building will house office and bench laboratory facilities and the other half will contain the pilot plant area. The laboratory will have the most advanced tools for research as well as an extensive technical library. The pilot plant will house facilities for studies in coke making, sintering, steelmaking and coating of steel products.

WILL INCREASE ALLOY HEAT-TREAT CAPACITY

△ Alloy steel plate heat-treating capacity will be increased at Homestead District Works of United States Steel Corp., it was announced by Robert A. McClure, general superintendent.

A second continuous quenching and tempering facility for the heat treatment of constructional alloy steel plates, including USS "T-1" Steel, is to be installed at the 160-in. plate mill.

The new line will be almost identical to the original facility already operating, and will require about one year to complete after the start of construction.

In addition to heat treating alloy steel plates for highly stressed industrial applications, the line will process steels for such military uses as missiles, aircraft, submarines, surface ships and atomic energy equipment.

AIR PRODUCTS TO BUILD FOUR OXYGEN PLANTS

△ Air Products, Inc. has announced plans for four major oxygen producing facilities for the steel industry. Total investment exceeds $33,000,000.

Among the new plants the company will build is a 535 ton per day oxygen plant in Cleveland, Ohio. The major portion of plant production will be supplied to Jones & Laughlin Steel Corp.'s Cleveland Works for the new basic oxygen furnace installation.

Also, a 340 ton per day plant will be built and operated by Air Products to supply oxygen for the

HOW TO BEAT THE HEAT

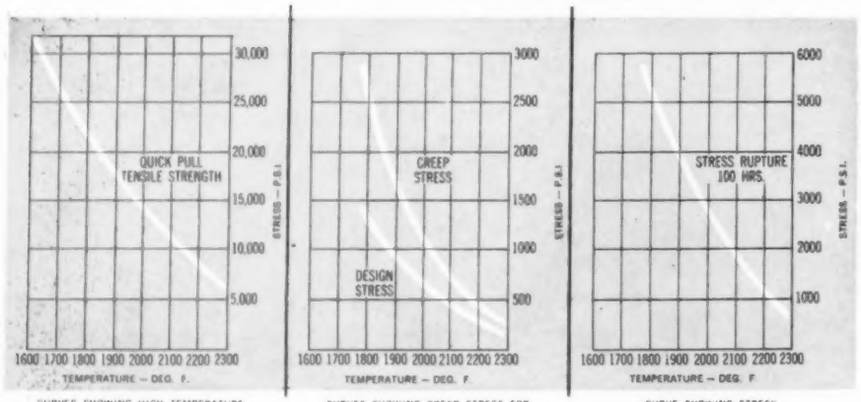
for strong high alloy requirements in the 1,800° to 2,300° F range!

DURALOY HOM*

*Covered by U.S. Patents

casting alloy

Duraloy "HOM" is a special high nickel alloy developed to produce castings that meet high temperature requirements, especially when castings are subject to oxidizing atmospheres.



CURVES SHOWING HIGH TEMPERATURE SHORT TIME TENSILE STRENGTH OF DURALOY HOM

CURVES SHOWING CREEP STRESS FOR CREEP RATE OF 1% IN 10,000 HOURS AND RECOMMENDED DESIGN STRESS FOR DURALOY HOM

CURVE SHOWING STRESS TO RUPTURE AT 100 HOURS FOR DURALOY HOM

Castings of DURALOY "HOM" are now being produced by our three methods: static, centrifugal and shell molded. Write today for additional information on this versatile new alloy.

The DURALOY Company
OFFICE AND PLANT: Scottdale, Pa.
EASTERN OFFICE: 12 East 41st Street, New York 17, N. Y.
ATLANTA OFFICE: 76—4th Street, N.W.
CHICAGO OFFICE: 332 South Michigan Avenue
DETROIT OFFICE: 23906 Woodward Avenue, Pleasant Ridge, Mich.

J & L Pittsburgh open hearth program. An existing 100 ton per day Air Products plant has been supplying oxygen for general plant use and open hearth test programs for more than three years. The new facility will enable this J & L location to carry out full conversion of the existing open hearths to the oxygen roof-lancing technique.

In addition, Granite City Steel Co. has launched an expansion program which will entail more use of oxygen for the open hearth roof lancing technique. Existing oxygen requirements are supplied from a 70 ton, per day Air Products plant. The additional oxygen required by the expansion will be provided by a 170 ton per day plant. Most of the production of this plant will be supplied to Granite City. However, a substantial portion of the facility will be distributed to general industrial users in the St. Louis area. Tonnage quantitites of nitrogen and argon will also be produced for general industrial use.

The largest of the group will be built and operated by Air Products for Weirton Steel Co., Division of National Steel Corp. This plant will produce 650 tons per day for use in both blast furnaces and open hearth furnaces. Weirton has obtained oxygen since 1951 from a 525 ton per day Air Products plant and from a medium size Air Products plant that was installed a few years ago. When the new facility goes on-stream, Weirton Steel will have available well over 1100 tons per day of oxygen capacity.

RCA AND FOXBORO OFFER JOINT PROCESS CONTROL

△ The first completely-integrated industrial process control system linking an all-transistor computer and advanced electronic instrumentation was announced jointly by the Radio Corp. of America and The Foxboro Co.

Under the arrangement Foxboro is to act as a manufacturer's representative for the sale of RCA's industrial computer products as well as to provide specialized instrumentation and process information.

RCA has an industrial computer systems activity within its Electronic Data Processing Division. This group will supply the computer

Unusual Bearings

For Unusual Applications

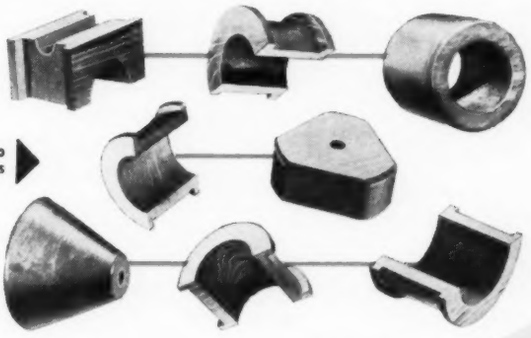
Cooper Split Roller Bearings
Cartridge Units
Pillow Blocks
Flange Units

WHEN you want an unusual bearing for an unusual application--you can always *get it in a hurry* from Berry.

Because, included in Berry's huge regular inventory are all the usual bearings...and... the unusual ones, too--in a wide range of shaft sizes. Also, Berry will make special bearings to your order.

So, for *immediate action* on *anything* you need in bearings, bearing specialties, or transmission appliances--don't hesitate to phone bearing headquarters.

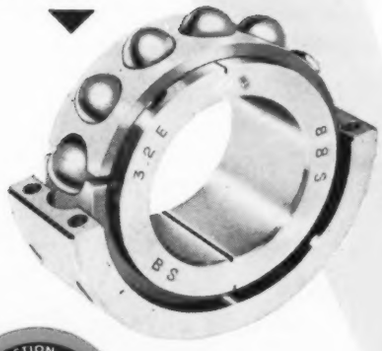
Thompson Linear Motion Ball Bearings
Solid, Split, Adjustable



Arguto Wooden Bearings

Thompson Nylined Sleeve Bearings

Split Ballbearings



Bronze Graphited Split Bearings

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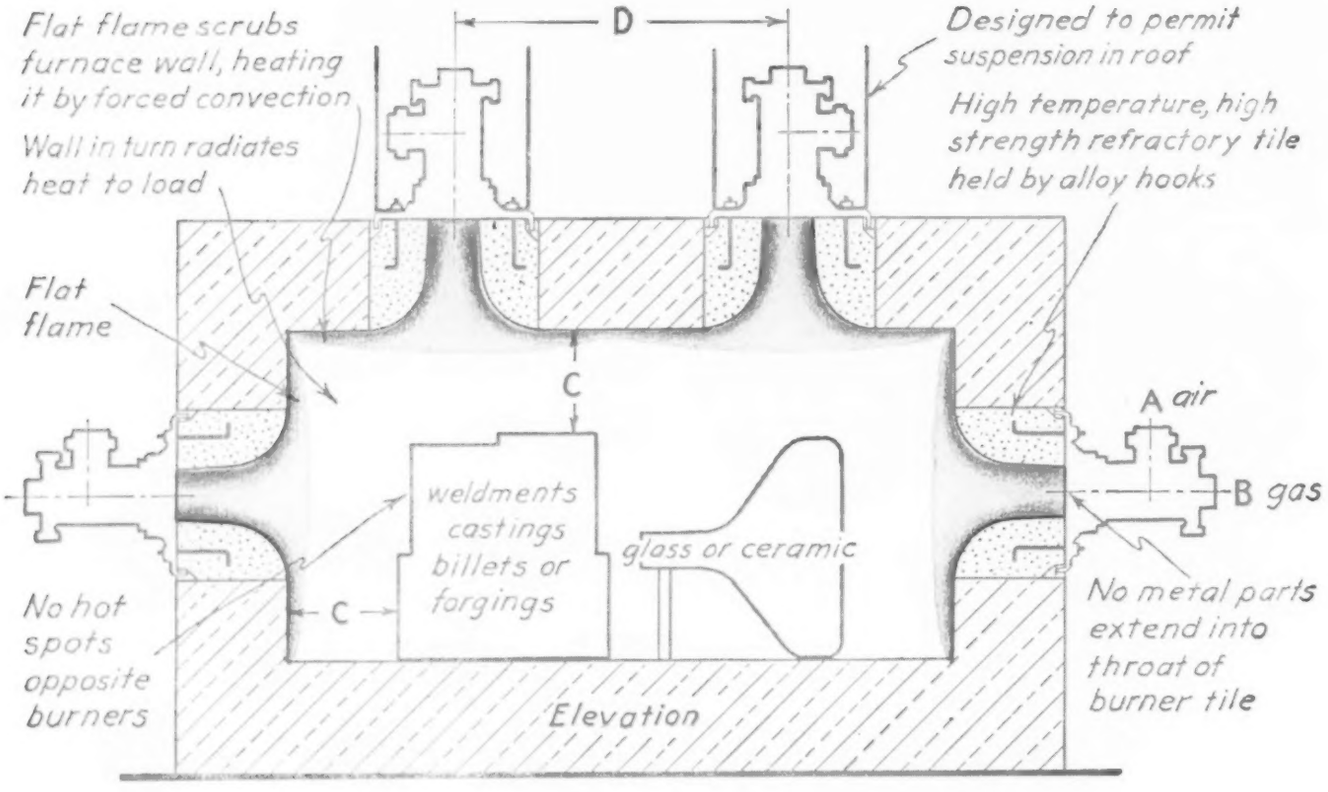
LUdlow 5-4400	EUclid 6-1700	Orchard 4-6600	MAjestic 3-8770	Phone 2-5561	WEstmore 1-3010	TUrner 5-7501	SKyline 4-6300	JOliet 3-3446

Put Your Furnace Walls and Roof to Work with
North American FLAT FLAME BURNERS

More Production — No Hot Spots


Flat flame scrubs furnace wall, heating it by forced convection
Wall in turn radiates heat to load
D
Designed to permit suspension in roof
High temperature, high strength refractory tile held by alloy hooks
Flat flame
C
A air
B gas
weldments castings billets or forgings
glass or ceramic
C
No hot spots opposite burners
No metal parts extend into throat of burner tile
Elevation

This Sketch shows how your North American Combustion Engineer might suggest using Flat Flame Burners to get the fullest use from your furnace — by putting a bigger pay load closer to walls and roof without flame impingement. (Figures for typical applications are listed in the table below.)

Each flame actually turns the corner of its specially shaped tile to give a temperature uniformity never before possible with so few burners. These nozzle-mix burners have an exceptionally wide turndown range and can be operated on correct air-fuel ratio or with excess air.

BURNER	A, Air Pipe Size	B, Gas Pipe Size	C, Suggested Min. Wall to Load	D, Suggested ℄ to ℄		Specifications
				Minimum	Maximum	
4832-2 & 4836-2	1¼″	1″	9″	13½″	30″	
4832-3 & 4836-3	1½″	1″	9″	16″	36″	Series 4832 has a
4832-4 & 4836-4	2″	1¼″	9″	18″	48″	13½″ square tile.
4832-5 & 4836-5	2½″	1½″	11″	24″	62″	Series 4836 has a
4832-6 & 4836-6	3″	2″	12″	27″	77″	24″ square tile.
4832-7 & 4836-7	4″	2½″	14″	33″	100″	

For engineering information, call your nearby North American Combustion Engineer or write for bulletins

NORTH AMERICAN for COMBUSTION and Hydraulic Controls

The North American Mfg. Co.
Cleveland 5, Ohio

products, electronics engineering and basic programming.

The new RCA 110 industrial process control computer system uses advanced circuitry and components from the RCA 501, fully-transistorized electronic data processing system for business, industry and government. Capable of making its own decisions, the RCA 110 employs both magnetic core high-speed memory and magnetic drum memory storage. Given an initial order in simplified code, the computer automatically sets up its detailed handling of the task in hand.

MESTA TO FURNISH NEW GARY TEMPER MILL

△ Mesta Machine Co. is designing and building a 48-in. two-stand temper pass mill and auxiliary equipment for the Gary Sheet and Tin Mill of United States Steel Corp.

Designed to skin pass cold reduced, annealed tin plate up to 42 in. wide at a maximum speed of 6000 fpm, the equipment will include two 48-in. temper mill stands, entry and delivery tension bridles, uncoilers, recoiler, horizontal belt wrapper, roll balance and auxiliary hydraulic systems and grease and oil lubricating systems.

Work rolls will be mounted in roller bearings, with oil bearings supplied for the tapered neck back-up rolls. Bottom back-up rolls will be direct driven through gear-type spindles.

To maintain a smooth flow of coiled material to and from the mill, Mesta will furnish auxiliary coil handling equipment, including two pallet type coil conveyors to deliver coils to the uncoilers, and two coil cars with elevating cradles to place the coils in position on the uncoiler mandrels. A coil buggy with elevating cradle will also be provided to service the tension reel on the delivery side of the mill.

COMBINE TWO DIVISIONS OF MIDLAND-ROSS CORP.

△ The John Waldron Corp., a subsidiary of the Midland-Ross Corp., and the Hartig Extruder Division of the same company have been combined and identified

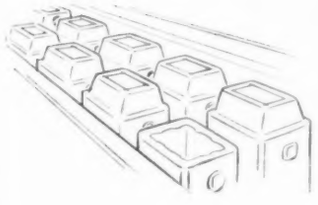
GREATEST SINGLE ADVANCE IN HOT TOP PRACTICE

R&I

HOT TOP MOLDIT CASTABLE REFRACTORY

for poured monolithic hot top linings

■ ***Exceptional insulating value***
permits reduction of hot top volume. In one plant, brick-lined hot tops had a volume of 14%. When relined with HOT TOP MOLDIT castable, volume was reduced to 12%. Yield of semi-finished, non-hot scarfed steel rose from 79.3% to 81.5%.



■ ***Far outlasts brick linings***
In one case, brick-lined hot tops had an average service life of 47.3 pours with a 15% hot top volume. HOT TOP MOLDIT linings had average service life of 79.6 pours with a 13% hot top volume.

■ ***Easily adaptable to die design change***
No trouble and delays as with firebrick linings. Mix HOT TOP MOLDIT with water and cast hot top lining right on the job.

■ ***Non-Wetting Properties***
Little, if any, parting compound required. Little chance of inclusions caused by parting compound falling into ingot mold.

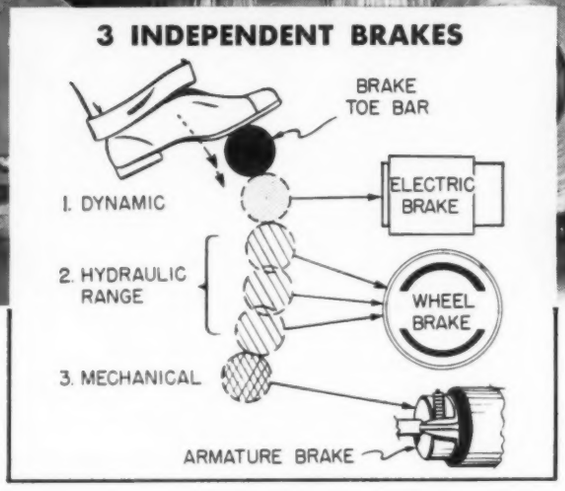
REFRACTORY & INSULATION CORP.

R&I

REFRACTORY BONDING AND CASTABLE CEMENTS
INSULATING BLOCK, BLANKETS AND CEMENTS

136 Wall St., New York 5, N. Y.

TRI-SAFE Braking — A Revolutionary New Safety Feature



...Now on all ELPAR Heavy Duty Ram Trucks

• "Putting on the brakes" can be a major undertaking with a 60,000 pound truck plus a 50,000 pound load! It's particularly hazardous on the rough and tumble handling jobs found in steel mills.

To end ram truck braking hazards, ELPAR developed the new TRI-SAFE brake system. Here's how it works: When the operator steps on the brake toe bar, the main power circuit is cut and dynamic braking slows the truck. In position two, the power hydraulic brakes are applied to bring the truck to a smooth controlled stop. In emergencies, the operator simply follows his natural reaction — pushes the toe bar to the floor applying a positive, fast acting mechanical brake. Note that the toe bar extends across the entire width of the truck permitting brake operation from any postion in the operator's compartment.

TRI-SAFE braking not only provides three-way brake safety, but it cuts brake wear too.

Dynamic braking slows the truck, thus reducing the load on hydraulic brakes. Result: brake shoe life is increased up to 4 times.

If you are interested in greater handling safety it will pay you to investigate Tri-Safe Braking. You can get it on any ELPAR heavy duty ram truck from 12,000 to 100,000 lbs. capacity.

Write for complete details today.

ELPAR
ELECTRIC TRUCKS

THE **ELWELL-PARKER** ELECTRIC COMPANY
4549 ST. CLAIR AVENUE • CLEVELAND 3, OHIO
In Canada: International Equipment Company, Ltd.

TWICE THE LIFE... ONE-THIRD THE OPERATING COST

as Waldron-Hartig Division of Midland-Ross Corp.

Waldron manufactures flexible couplings and a complete line of process machinery for paper, plastic, film, foil and metal webs. It has been known since 1827 as John Waldron Corp.

Hartig Extruders is one of the world's largest producers of plastic extrusion machinery.

ARMCO TO INSTALL NEW HOT-DIP COATING LINE

△ Armco Steel Corp. has completed negotiations and placed an order for the world's largest, fastest and widest hot-dip coating line with The Wean Engineering Co., Inc. The new line is to become a part of the Armco Middletown operation.

The line will be 565 ft long, and will process coils up to 50,000 lb in weight and 72 in. in width. The contract is being handled by Wean on a "turn-key" basis.

The 420 ft long cleaning and annealing furnace will be designed and built by the Electric Furnace Co. of Salem, Ohio. The McGraw Construction Co. will serve as the installation contractor.

The new production unit will be located in an entirely new building at the Middletown plant, adjacent and parallel to the existing coating lines. It is planned that the new line will be in production during the latter part of 1960.

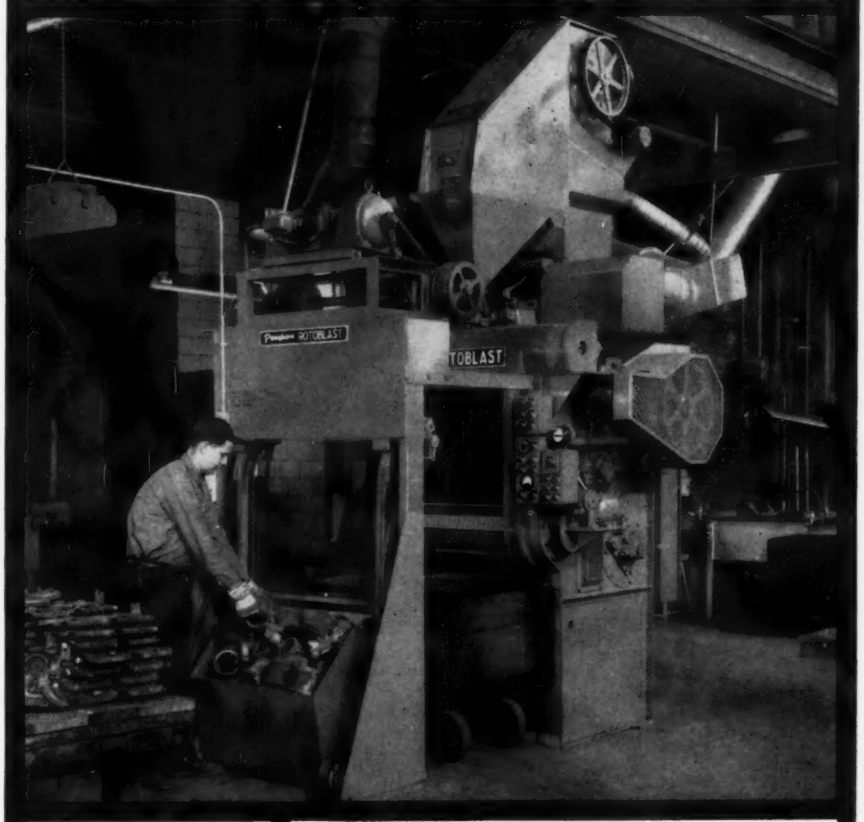
Meetings

△ A program of ten technical meetings has been prepared for the Seventeenth Annual Conference of the Electric Furnace Committee, Iron and Steel Division of The Metallurgical Society. The sessions will be held December 2–4, 1959, in the Cleveland Hotel, Cleveland, Ohio.

The Metallurgical Society is a constituent organization of the American Institute of Mining, Metallurgical and Petroleum Engineers.

THE COST OF AN AD
THIS SIZE IS $10.00
PER INSERTION

ROTOBLAST CUTS CLEANING TIME 70%!



Pangborn Rotoblast reduces cleaning time from 15 minutes per load to 4½ minutes at Buckeye Iron & Brass

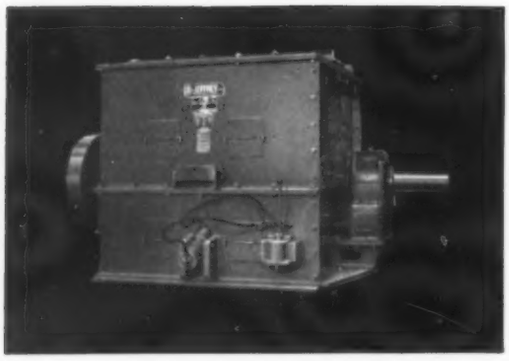
To reduce costs and still keep up production schedules, Buckeye Iron & Brass Works, Dayton, Ohio, replaced its centrifugal blast cleaning barrel (which is still in good operating condition) with an automated 6′ Pangborn Rotoblast Barrel. The result: cleaning time was cut from 15 minutes per load to 4½ minutes!

Through automation, the Rotoblast Barrel has also saved the company the cost of one full-time operator and has proved economical in terms of maintenance. In seven months, no repairs or replacements, other than vanes, have been necessary!

For full details on how Pangborn Rotoblast can save you money, write for Bulletin 706 to PANGBORN CORPORATION, 4400 Pangborn Blvd., Hagerstown, Md. *Manufacturers of Blast Cleaning and Dust Control Equipment—Rotoblast Steel Shot and Grit*

Pangborn CLEANS IT FAST WITH **ROTOBLAST®**

Jeffrey Pulverizer crushes fluxstone fine for efficient sintering



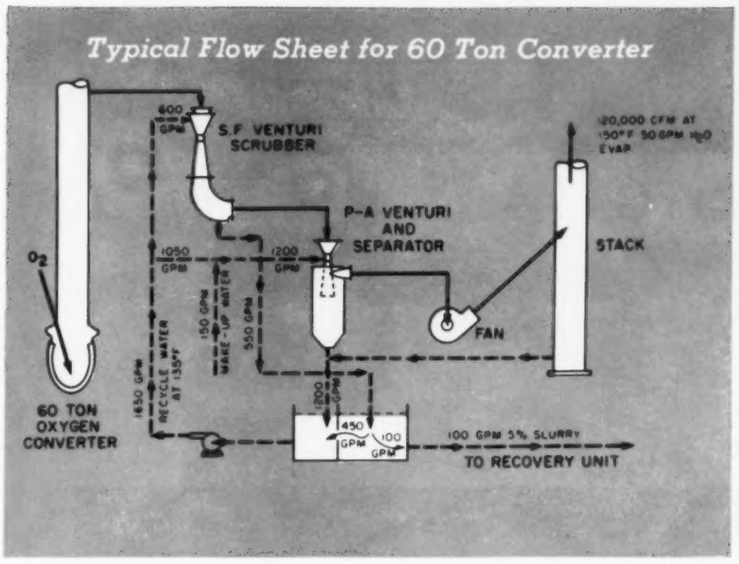
The Jeffrey Type B Pulverizer has many advantages in crushing fluxstone for sintering operations. It crushes *fine* – standard $\frac{3}{8}$", or $\frac{1}{8}$", when required. This is possible since the material goes through several changes in direction and several hammer contacts before it reaches the screen bars.

This unit is reversible, designed for heavy duty work, is dust-tight, and has hydraulic adjustments. Power requirements are less than with other units, since most of the work on the material is done before the material reaches the screen bars.

Fluxstone is but one of hundreds of materials which can be efficiently reduced with Jeffrey Crushers... from alum and asbestos to rock and slag. For complete information check your nearest Jeffrey sales engineer. The Jeffrey Manufacturing Company, 840 North Fourth Street, Columbus 16, Ohio.

JEFFREY

CONVEYING • PROCESSING • MINING EQUIPMENT...TRANSMISSION MACHINERY...CONTRACT MANUFACTURING



"virtually no maintenance since start-up on CHEMICO VENTURI WASHERS"

Where major investments are concerned, performance is vital. At the Algoma Steel Company's new Sault Ste. Marie Basic Oxygen Steel plant, Chemico Venturi washers are exceeding all original performance specifications. Case in point: since start-up in November, 1958, there has been virtually no maintenance on the Chemico washers. This is a normal record for Chemico washers. They are designed to eliminate shut downs for maintenance on gas washing systems, thus making it unnecessary to invest in spare equipment.

Chemico Venturis are paying Algoma other dividends, too, for these washers are operating at better than 98% efficiency. During test periods when operating at 50% over design capacity, the flexibility of the Chemico washers permitted the extra load to be handled without increased washing facilities.

If steel is your business and air pollution your problem, it pays to consider Chemico Venturi washers. You can obtain full information, a copy of a detailed technical brochure, and technical assistance concerning your problem by writing Chemico today.

CHEMICO

CHEMICAL CONSTRUCTION CORPORATION
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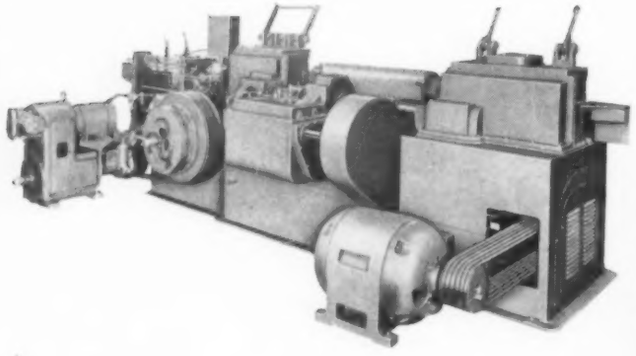
CHICAGO • DALLAS • HOUSTON • PORTLAND, ORE. • TORONTO • LONDON • PARIS • JOHANNESBURG • TOKYO

Meet your Profit Challenge with LEWIS Wire Straightening and Cutting Machines

There is a Lewis machine for every possible purpose in the wire straightening and cutting field. And Lewis engineers are constantly working on new designs and developments to further improve performance. There are 46 models in the Lewis line.

Lewis machines are designed to do the highest quality job of wire straightening and cutting in rounds as well as shapes. For speed, accuracy and clean cutting, they have no equal anywhere.

In every possible way, Lewis Machines meet the challenge of today's production requirements.



Lewis No. 11-FA Travel-Cut with Flying-Shear Cut-Off. Capacity ½" to ¾" diameter, 75-175 FPM.-Rear view with guards removed showing Air Clutch and drive.

The combination of Air Brake, Air Clutch and Variable Speed Drive permits higher cut-off speeds... and allows infinite adjustment of the flywheel for perfect synchronization of cut-off and wire feed speeds... rod can be cut WITHOUT SPOT SWELL.

Lewis No. 20-F Travel-Cut SHAPE Straightening and Cutting machine. Capacity 5/16" to 5/8" square, hex or equivalent area in flat stock.

The Travel-Cut Flying-Shear Cut-Off is particularly advantageous on shape machines to better synchronize the cut-off with the through speed of the wire. This is necessary to eliminate roll rub marks and reduce roll wear to a minimum.

N.B.

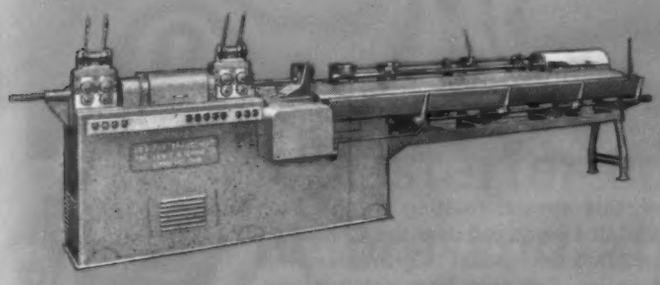
A New 1" Machine.

The new Lewis No. 12-FA High-Speed, Flying-Shear type Wire Straightening and Cutting Machine is now being developed to handle rod up to 1" in diameter from coils at output speeds much greater than on any existing equipment.

TIMKEN Tapered Roller BEARING EQUIPPED

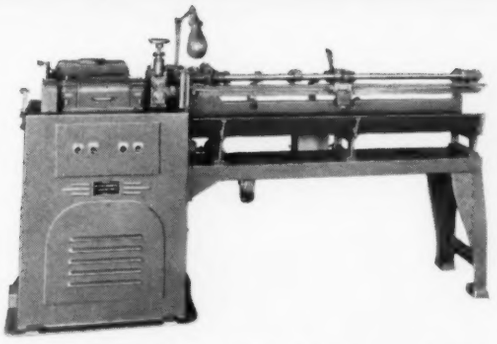
Lewis No. 2CV4 Automatic Wire Straightening and Cutting Machine with variable speed drive and Dual-Center Straightening Arbor. Capacity 1/16" to 1/4" diameter. No. 2CV5 Capacity 1/16" to 5/16" diameter. Feed speeds up to 200 FPM.

The Lewis 2CV Series can be quickly converted to handle shapes by installing our interchangeable Roll Straightener in place of the Dual-Center Rotary Straightener Arbor.



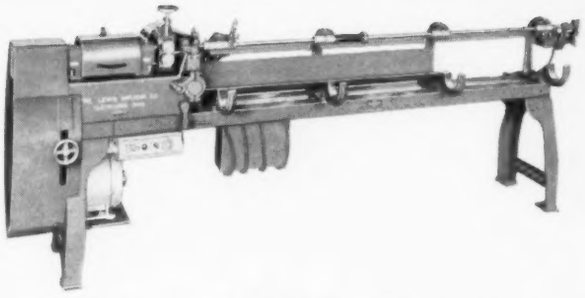
Lewis No. 4-FHA Travel-Cut Automatic High-Speed Flying-Shear Wire Straightening and Cutting Machine with Wichita Air Clutch and Air Brake. Capacity Mild Steel, 3/32" to 1/4" diameter. High Carbon, Alloy and Stainless, 3/16" diameter. Speeds up to 500 FPM.

The Dual-Center Straightener Arbor (Pat. Pend.) permits use of close centers for small diameters and long centers for the larger diameters for precision straightening over entire range of machine.



Lewis No. "O" Electric-Air. Especially designed for straightening and cutting fine wire sizes. Capacity .012" minimum to .0625" music wire, .072" spring wire, .080" basic wire.

Extremely fast air-operated cut-off eliminates Flywheel and Clutch...Variable Speed Drive provides wire feed range of 15-90 FPM ... precision length gauging, plus or minus .0025 in 6" length ... highest quality finish.



Lewis No. 1-C Automatic Wire Straightening and Cutting Machine. 1/16" to 1/8" capacity.

Greater flexibility with Multiple Speed Drive in a low cost machine. High-speed Five-Die Rotary Straightener Arbor, mounted on ball bearings. Available with super-sensitive electric trip mechanism.

LEWIS

MACHINE COMPANY
3441 EAST 76TH STREET
CLEVELAND 27, OHIO

A new money-saver from Whiting's Custom Crane Department, this special rotating crane was developed for a Chicago publishing firm. Dock-anchored at one end, it swings out over the Chicago River to unload paper-laden barges. Unusual remote operator's cab also swings out to give full view of action. High unloading speed saves valuable time, cuts man hours. Full view from cab avoids damage to paper rolls, assures complete safety. All this from Whiting, where 75 years of crane experience add up to a wealth of working knowhow. Call Whiting whatever your needs in custom or standard cranes.

FREE BULLETIN . . . quick, clear introduction to features of Whiting cranes. Write for Bulletin 80. *Whiting Corporation, 15655 Lathrop Avenue, Harvey, Illinois.*

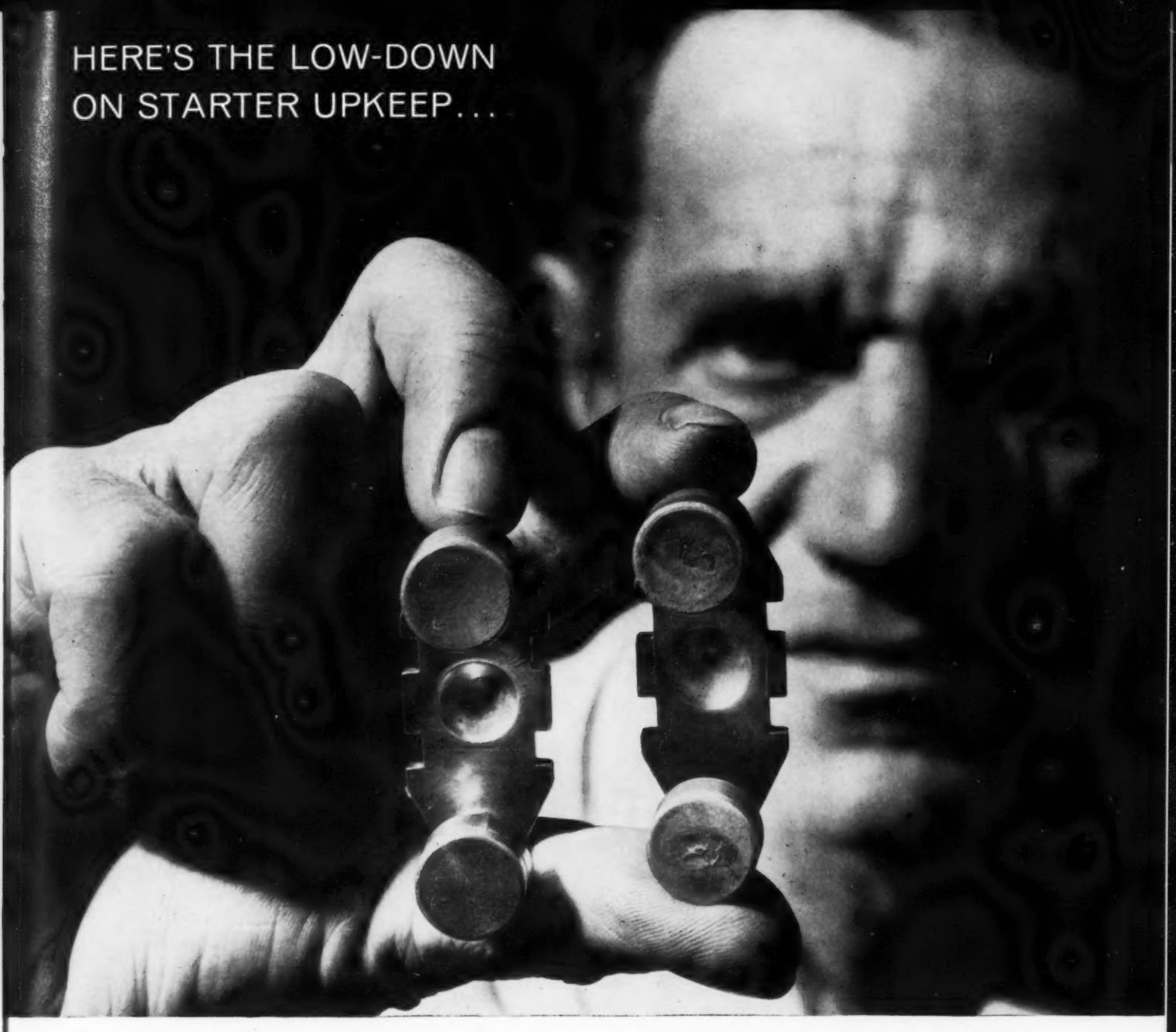
75th year

COST-SAVING EQUIPMENT...THE WAY TO HIGHER PROFITS

CRANES

WHITING

MANUFACTURERS OF CRANES; TRAMBEAM HANDLING SYSTEMS; TRACKMOBILES; FOUNDRY, RAILROAD, AND SWENSON CHEMICAL EQUIPMENT



Can your starter contact tips match this before-and-after comparison?

The unretouched photograph above shows two sets of contact tips from a Clark Type "CY" A-C Motor Starter. One set has seen a year of continuous hard service with frequently as many as 5,000 operations per hour. The other set is brand new – unused.

Which contact tips were actually in service for one year? The obvious, but not too obvious clue is the slight discoloration and minute pitting in the tips at right above.

But you can easily see for yourself that even after one year of steady operation these tips show very little evidence of wear. Their present condition will assure many more years of dependable service, free of maintenance.

The secret? Clark's exclusive "arc quenching" principle incorporating the use of strong, multi-turn magnetic blowouts and double-break contacts.

The action of the magnetic field not only forces the arc to rotate, moving it continually over contact surfaces, but tends to "quench" it at the same time. Result: Less wear on contact tips and fewer maintenance headaches.

There are many more good reasons why the Clark Type "CY" Starter is your best *preventive* maintenance buy. For complete details contact your nearest Clark Controller sales office or distributor. Or, write direct. 9S1

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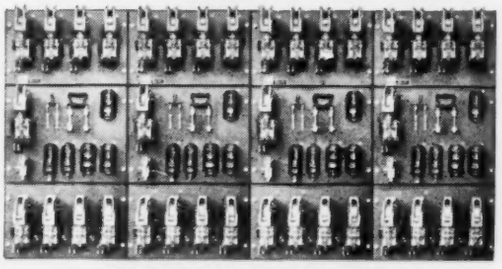
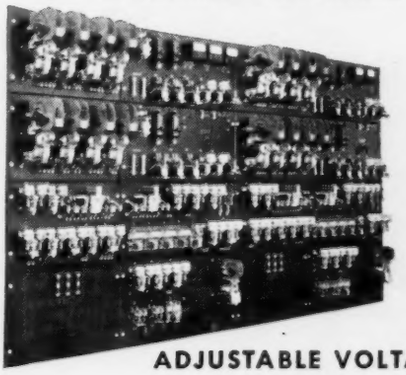
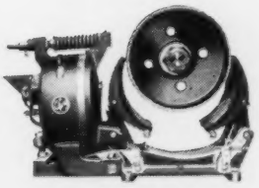


CONSTANT POTENTIAL

1. Speed Control Master Switch



ADJUSTABLE VOLTAGE



2. Dual-Coil Series or Shunt Wound Brakes

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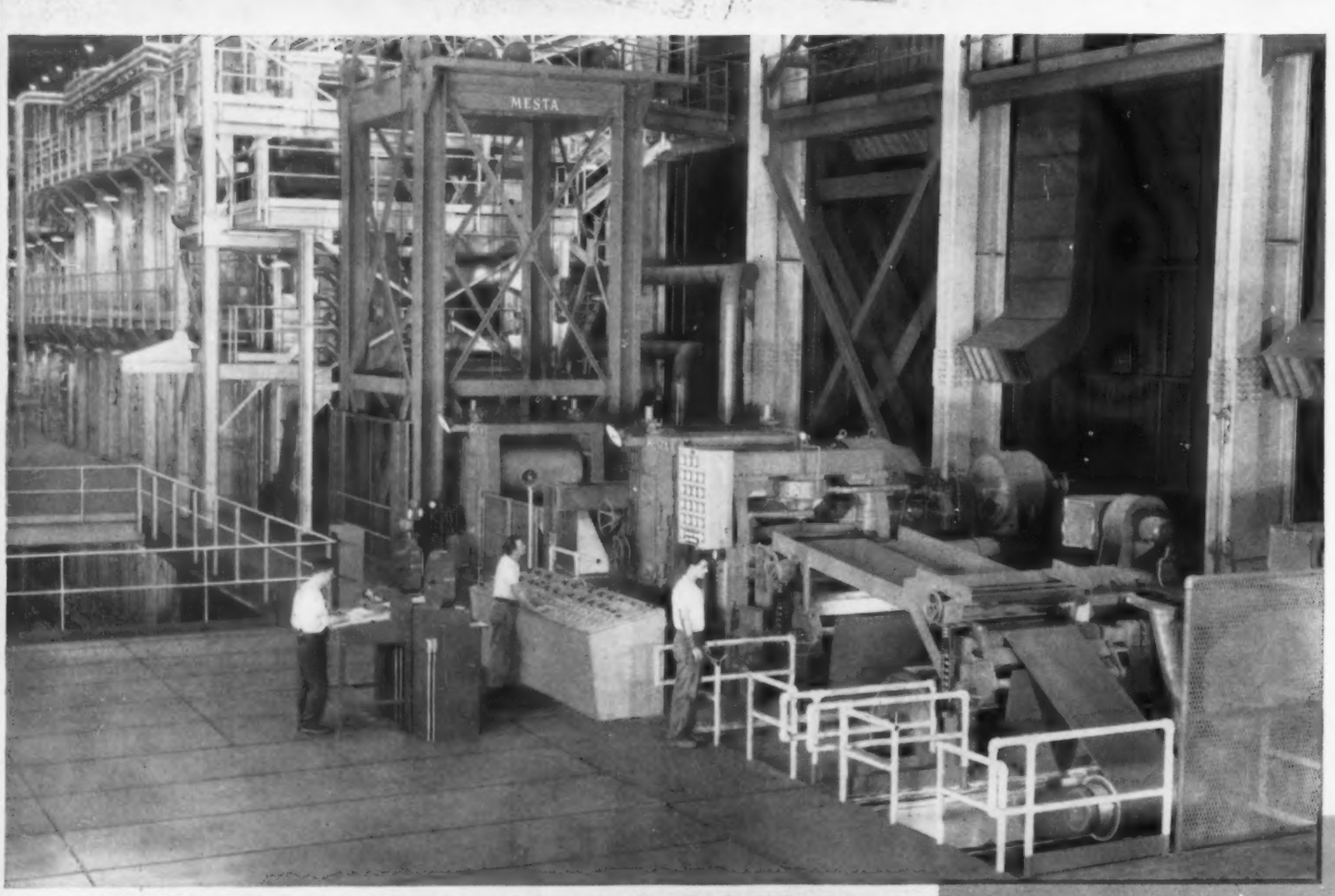
Designed and Built by MESTA



MESTA 2000 FPM Continuous Cleaning and Annealing Line for Steel Strip in Tin Plate Gauges with Pay-Off Reels, Mash Welder and Tension Reels in Operation at Weirton Steel Company, Division of National Steel Corporation.

Designers and Builders of Complete Steel Plants

MESTA MACHINE COMPANY

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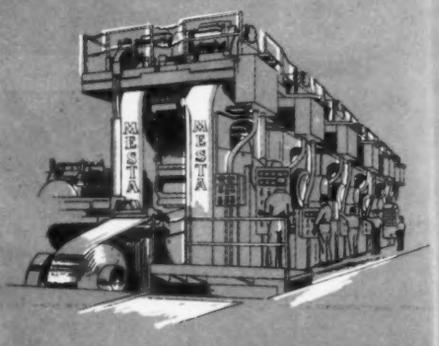


Personnel News...

Michael Zetz has been appointed plant manager for the Louisville, Ohio, plant of the Jones & Laughlin Steel Corp., Stainless and Strip Division. Mr. Zetz, who formerly was superintendent of quality and production control at the Louisville Plant, joined J&L in this capacity in 1958. Formerly associated with Crucible Steel Co. of America, Mr. Zetz has spent his entire career in the steel industry.

John Plesa has been appointed assistant chief metallurgist at Weirton Steel Co., division of National Steel Corp. Mr. Plesa succeeds **Harold Leuthke,** who recently was named chief metallurgist at Midwest Steel Corp. Mr. Plesa began working at Weirton in 1941 as assistant to the metallurgist. He later worked at the quality control laboratory, the sheet mill, the 54-in. strip steel department, and the Steubenville plant before being named tin mill metallurgist in 1952, the position he held until his current appointment.

T. J. Peters has been appointed as director of plant engineering and construction for Acme Steel Co. Mr. Peters joined Acme in 1954 as director of construction and maintenance. Prior to that he was division superintendent at South Works of United States Steel Corp.

D. A. Bessmer was elected president of The Timken Roller Bearing Co., succeeding **Wm. E. Umstattd.** Although retiring as president in accordance with company policy, Mr. Umstattd will continue to serve as a director and as chairman of the executive committee. Mr. Bessmer has been serving as executive vice president. **H. E. Markley** will advance from vice president to executive vice president to succeed Mr. Bessmer. **H. H. Timken, Jr.,** is relinquishing the title of executive vice president, but will continue to be chairman of the board of directors. **W. R. Timken** is relinquishing the title of vice president, but will continue to serve as chairman of the finance committee.

Mr. Bessmer joined the Industrial Division of Timken in 1933. Following the completion of a training course, he was sent to the Detroit office of the Automotive Division as a service engineer in 1934. A short time later he became a sales engineer. He was recalled to the main office in Canton in 1940 to enter the company's Purchasing Department. In 1942 he was made director of purchases. Named assistant to the president in 1950, he was elected a vice president in 1953. In 1957 he was elected executive vice president, the position he held until his election to president.

Mr. Umstattd, president of Timken since 1934, joined the company in 1919. Starting in the bearing factory as an inspector, he was elected president 14 years later. The Timken Co. more than tripled in size under his direction.

Earl D. James has been appointed manager of the Strip Steel Department, Weirton Steel Co., succeeding **George F. Harmuth,** who retired August 31. **John D. Sutherland** has been named an assistant general superintendent.

Mr. James started his Weirton Steel career in the Accounting Department in 1919. He spent two years in the Steel Works and then transferred to the Strip Steel Department. He was named chief inspector in 1930 and then became successively superintendent of the cold mill, superintendent of the 10–16 in. mill, assistant manager of the Steubenville plant and assistant manager of the 54-in. strip steel mill. He was named manager of the 54-in. mill in 1947.

Mr. Sutherland joined Weirton after 19 years with United States Steel Corp. For the past two years, Mr. Sutherland has been division superintendent of steel products and foundries at U. S. Steel's Homestead, Pa., works.

Mr. Harmuth began his employment with Weirton Steel in 1921. He started as billet yard foreman in the 10–16 in. Strip Steel Department, moved up to cold mill superintendent, and in 1927 was named assistant manager of the Strip Steel Department. He was appointed manager in 1936.

Edward S. Wright has been appointed vice president-general manager of the Power Piping Division of Blaw-Knox Co., succeeding **W. E. Parfitt** who has resigned. Mr. Wright has been vice president-manager of con-

MICHAEL ZETZ

JOHN PLESA

T. J. PETERS

D. A. BESSMER

T. C. SMITHSON

C. F. SIMMERS

CHARLES RINDERLE, JR.

J. H. WERNER

struction of the company's Chemical Plants Division. He has been an employee of Blaw-Knox for 17 years.

Tom C. Smithson has been promoted to superintendent, coke plant department, Middletown plant, Armco Steel Corp. Mr. Smithson succeeds **Joseph McLaughlin** who died recently. He was formerly general foreman of the Middletown coke plant department. Mr. Smithson joined Armco in 1928 as a battery foreman of the Hamilton, Ohio, coke plant department. He moved up to turn foreman, foreman and then by-product foreman in 1946. In 1952, he was transferred to the Middletown coke plant department as general foreman.

Charles F. Simmers has been appointed assistant chief engineer, Engineering and Construction Division, Koppers Co., Inc. Mr. Simmers will assist the chief engineer in the execution of engineering design for industrial and steel mill plants, furnaces, sintering plants, by-product coke plants and special equipment. Prior to his new appointment, he was doing consulting engineering work on rolling mill equipment and special steel mill cranes. For 11 years, beginning in 1948, Mr. Simmers was associated with the Morgan Engineering Co. in various engineering supervisory positions, with the last 4 years as vice president—engineering and member of the operating committee. During the preceding 18 years, he was associated with United Engineering and Foundry Co., Berger Engineering Co., including 16 years with U. S. Steel Corp.

Charles Rinderle, Jr., was elected vice president of Southwest Steel Rolling Mills.

J. H. Werner was named sales manager of Lee Wilson Engineering Co., Inc. Formerly assistant sales manager, Mr. Werner will take over duties previously handled by **J. L. Whitten,** vice president, who will now devote more of his time to company policy. Mr. Werner joined Lee Wilson in 1941, starting as service engineer. He later served as production manager, sales engineer, district manager—Chicago, and most recently, assistant sales manager.

Donald A. Booth has been appointed engineering manager for Engineering Works Division of Dravo Corp. He had been assistant engineering manager for the past year. Mr. Booth joined Dravo as an engineer in 1935. His experience with Dravo has included field engineering, costs, plant and industrial engineering, and a number of supervisory positions. After several years as general mechanical superintendent of Engineering Works Division, he was named chief draftsman in 1956.

Donald R. Smith was promoted to plant manager, The Ironton Fire Brick Co. His duties will be the operation of the plant in Ironton, Ohio, and the mines at Soldier (Olive Hill District), Ky. Mr. Smith's former position was manager of the Special Products Division. He started at Ironton in 1941 in the research and control laboratory.

T. L. Dineen was named manager, general industrial sales, Allis-Chalmers Manufacturing Co., Cleveland District. **Roger W. Cavanaugh** was named manager, metals industry sales; **W. F. Bueche,** manager, utility sales, and **R. M. Morrow,** supervisor, original equipment manufacturers and distributor sales.

Mr. Dineen had been manager of metals industry sales in the Cleveland district since 1958 and prior to that a sales representative there for five years. Mr. Cavanaugh had been a sales representative in the Cleveland district since 1954. Mr. Bueche was assigned to the Cleveland district in 1954 as a sales representative. Mr. Morrow has been a sales representative in the Cleveland district since 1957 and before that was a representative in the Cincinnati district for three years.

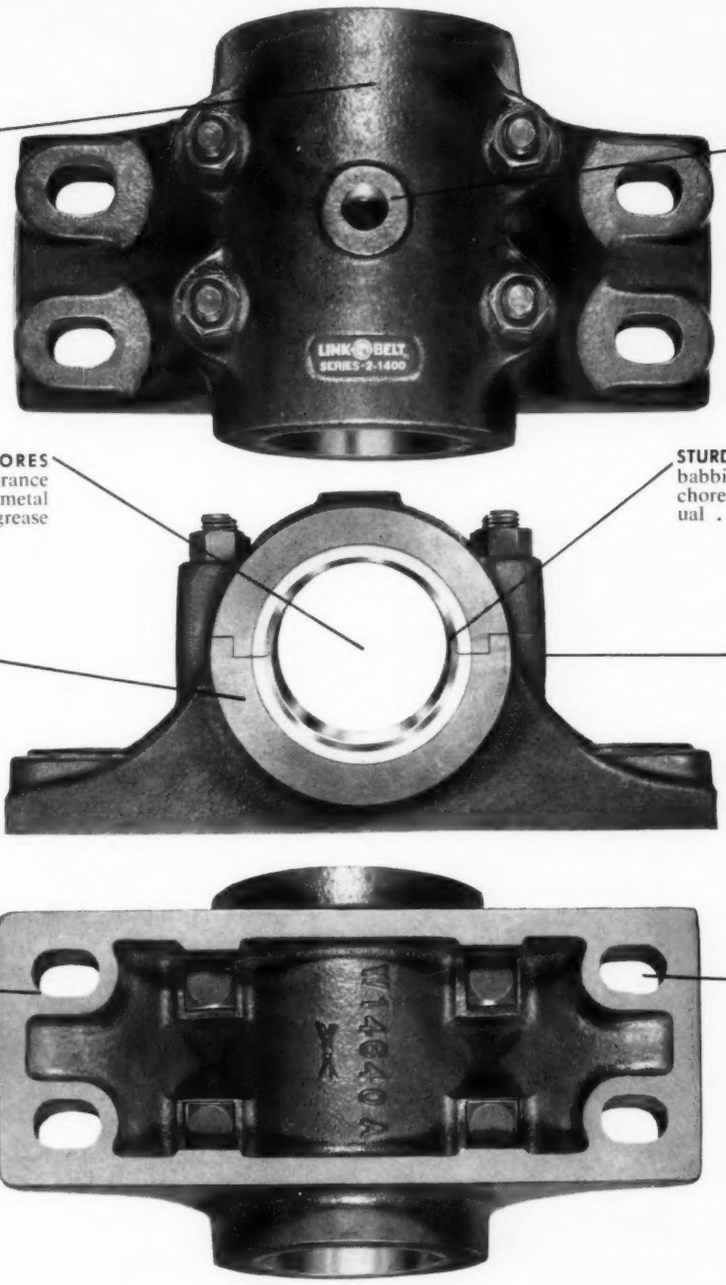
Edwin A. Yeo, Jr., has been promoted from district manager in Chicago, Ill., to the new post of assistant manager in the Sales Division, Leeds & Northrup Co. **Willard H. Neu** moves from district manager at Pittsburgh, Pa., to district manager at Chicago. **Manley S. Nolen** transfers from Cincinnati, Ohio, district manager to Pittsburgh district manager. **Charles W. Sullivan,** branch manager of the Columbus, Ohio, office, advances to Cincinnati district manager. **John C. Scott, Jr.,** is promoted from field engineer at Columbus to branch manager there. **John C. Emerline** is promoted from branch manager at Baltimore, Md., to St. Louis, Mo., district manager, the position formerly held by **John F. Sneath,** who becomes technical assistant field inquiries, in Philadelphia, Pa. **George J. Demos** is promoted from resident engineer at Albany, N. Y., to branch manager at Baltimore. **Philip H. Kuhl** advances from sales engineer at Cleveland, Ohio, to resident engineer at Albany.

E. K. Leavenworth has been appointed a vice president of Climax Molybdenum Co. Mr. Leavenworth will continue to be headquartered at the company's Coldwater, Mich., plant where he serves as works manager.

Sound design, solid construction

...all the way around!

LINK-BELT BABBITTED AND BRONZE BEARING BLOCKS



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RELIABLE LUBRICATION — Holes for grease cups or pressure fittings are drilled and tapped. Grooves distribute lubricant over entire shaft surface.

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NEW DATA BOOK 2707 has full information on Link-Belt's complete line of babbitted and bronze bearing blocks and takeups. Link-Belt offers off-the-shelf delivery on more than 15 types and over 300 sizes of solid, split, gibbed or angle pillow blocks . . . for commercial shafting up to 12″ diameter. Also immediate delivery on flanged blocks and takeups in all popular sizes. For your copy of Book 2707, contact your nearest Link-Belt office or authorized stock-carrying distributor. Refer to the yellow pages of your local telephone directory.

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Delbert A. Burman has been appointed assistant director of purchases by the Crucible Steel Co. of America. He was formerly buyer in the company's Purchasing Division. Mr. Burman came to Crucible in 1957 after 10 years of service with the Ford Motor Co.

James W. Wilcock has been appointed manager of the Sturtevant Division of Westinghouse Electric Corp. Mr. Wilcock has served as marketing manager of the division since 1956. Prior to joining Westinghouse in 1956, he was general sales manager for the Berry Division of Oliver Iron and Steel Corp.

Henry S. Hall has been named manager, Combustion Control Division, Morgan Construction Co. He has been associated with Morgan for the past 10 years, most recently as assistant manager of the Division. Before coming to Morgan, Mr. Hall had been the manager of the Fuel and Steam Department of Lukens Steel Co. Previous to that he had been in the Open Hearth Department of Armco Steel Corp. for 12 years. In his new position Mr. Hall succeeds **Strickland Kneass, Jr.,** who has been appointed consultant to the company. Named assistant manager under Mr. Hall is **John J. Webber,** who for the past three years has been a sales engineer with the Harbison-Walker Refractories Co. Mr. Webber had been for nine years furnace design engineer with Owens-Corning Fiberglas Corp. Other executive changes announced were the appointment of **Warren H. Howard** as Pittsburgh district managing representative; and the appointment of **Samuel S. Rickley** as chief engineer of the Morgoil Bearing Department of the Morgan Construction Co. Prior to his association with Morgan, Mr. Howard was an industrial sales manager with General Electric Co. His previous positions with General Electric included engineering work in industrial sales in Worcester, Mass., and in the Steel Mill Division located in Schenectady, N. Y. Mr. Rickley, for the past two years Pittsburgh district managing representative, will return to the main office in Worcester, Mass. Prior to his eight years of association with Morgan, Mr. Rickley was chief engineer of the Superior Steel Corp.

Alex McClure has been named general sales manager of the Pacific Coast Engineering Co. Mr. McClure was formerly sales manager for American Glass Fibers, Inc.

E. S. Mathiesen has been appointed vice president in charge of manufacturing, Cutler-Hammer Inc. Mr. Mathiesen, formerly works manager at Milwaukee, succeeds **W. F. Lent,** who will continue as a vice president with broad company assignments. Mr. Mathiesen began work in the firm's engineering department in 1929. He became assistant works manager in 1950, holding that post until 1958 when be became works manager. Mr. Lent began his career with the company as an application engineer. He became works manager in 1950 and vice president in charge of manufacturing in 1956.

Peter A. Spuhler has been appointed as sales engineer in the Salem-Warren-Youngstown, Ohio, area by Hunt Valve Co.

E. W. Shuster has been named co-ordinator of foreign business for the E. W. Bliss Co. In his new capacity, Mr. Shuster will be responsible for co-ordinating company-wide policy for all foreign operations of the company, including manufacturing subsidiary companies at Derby, England, and Paris, France.

H. A. Lampmann has been appointed manager of European sales engineering for the company's Rolling Mill and Mackintosh-Hemphill divisions, succeeding Mr. Shuster.

Gillette N. Houck has been named assistant to the manager of the Electrical Conductor Division, Kaiser Aluminum & Chemical Corp. At the same time, **Cecil R. Pickens** becomes division technical manager. Mr. Houck, formerly division manager of promotion and technical development, joined Kaiser Aluminum in 1947. Prior to that he had served with Firestone Tire and Rubber Co. and Beech Aircraft Corp.

Mr. Pickens joined Kaiser Aluminum in early 1957 when the firm acquired the Wire and Cable Department of United States Rubber Co. He had been with U. S. Rubber for eleven years. Prior to his latest promotion he served as a project engineer.

John G. McLain was named as western manager of Foundry & Mill Machinery sales, Blaw-Knox Co. It was also announced that **Gilbert C. Berquist,** roll sales engineer, has been assigned to the West Coast. Mr. McLain joined the company in 1946 and his background includes experience in the sale of rolls, rolling mill machinery, and steel plant equipment. He is a native of Weirton, W. Va., and a graduate of Washington College in Maryland. Mr. Berquist has been a sales engineer in the Aetna-Standard Division of Blaw-Knox Co.

H. S. HALL

W. H. HOWARD

S. S. RICKLEY

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General Dynamics Corporation
Liquid Carbonic Division
MARYLAND
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Charles Peirce Associates
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General Dynamics Corporation
Liquid Carbonic Division
MINNESOTA
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OHIO
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OREGON
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P. G. MAYER

G. L. SANDERS

W. L. GOVAN

F. W. GROSICK

Paul G. Mayer was named general sales manager of the Loewy-Hydropress Div., Baldwin-Lima-Hamilton Corp. He succeeds **Frederick A. Fielder** who became vice president and general manager of the division. Mr. Mayer, who has been with the Loewy group and its former affiliates in England, and in the United States for almost 25 years, had been assistant general sales manager since 1956. **Gerald L. Sanders** was appointed product sales manager, rolling mill department of Loewy-Hydropress Division. Mr. Sanders, a member of Loewy-Hydropress since 1947, has been assistant sales manager, rolling mills, for the last nine years. **William L. Govan,** chief project engineer of Loewy-Hydropress Division was appointed to assume the additional functions of product sales manager for hydraulic machinery. Mr. Govan has been with Loewy-Hydropress since 1951. **William R. Liebel** was appointed assistant product sales manager, rolling mills. He has been specializing in the design, installation and sales of rolling mills and auxiliary equipment for more than twenty years.

Felix Klein, becomes assistant product sales manager, hydraulic machinery. He has been associated with Loewy in England, Canada and the United States since 1939 in the field of design, production and sales of hydraulic metalforming machinery.

Frank W. Grosick was named sales manager, steel mill cranes, by the Harnischfeger Corp. Prior to coming with P&H, Mr. Grosick was for 13 years directly responsible for the design, application and maintenance of all cranes purchased for the various steel making divisions of Jones & Laughlin Steel Corp.

Sidney Wade has been appointed vice president—distributor products of Linde Co., Division of Union Carbide Corp. Mr. Wade began his business career with Union Carbide's Oxweld Acetylene Co. in 1921. He joined Linde in 1929 when Oxweld was merged with the company. In 1956 he was named manager of the gas apparatus department and two years later was appointed manager, distributor products, for Linde.

Charles H. Holley has been named manager—generator product engineering, General Electric Co.'s large steam turbine-generator department. **Edson D. Huntley** has been named generator electrical engineer, and **W. J. Gilson** has been appointed supervisor—generator requisition, proposition and maintenance engineering.

Donald E. Cummings has been appointed general manager of Air Products, Inc.'s new Industrial Gas Division. **H. E. Everett,** formerly Eastern regional manager of cylinder gas operations, has been named assistant general manager of the division. **John K. Stewart,** formerly manager of the Steel Mill Sales Division is now general sales manager, Industrial Gas Division.

B. E. Gallagher was named as resident engineer in Indianapolis, Ind., by Bailey Meter Co. Mr. Gallagher joined the company in 1946 an as engineering trainee, and was assigned to the Chicago district after completion of his training.

Kenneth C. Crain, Jr., has been appointed works manager, National Electric Division, H. K. Porter Co., Inc. **Robert Johnson** has been named director of engineering; **Everett L. Kimball** will be steel engineering manager; and **Robert A. Ditchendorf** has been made industrial engineering manager. All four will make their headquarters at National Electric's Ambridge Works, Ambridge, Pa.

Mr. Crain was formerly works manager of National Electric's Wire and Cable Division. Prior to joining the company in 1955, he was with the E. L. Wiegand Co. Mr. Johnson joined National Electric as chief engineer of the Steel Division in 1948. Prior to that he was employed in the sales division of the Ivers-Lee Co. Until his present appointment, Mr. Kimball had been assistant chief engineer of National Electric's Steel Division. Prior to coming to the company in 1958, he had been chief engineer, A.C.F. Industries, Buffalo, N. Y. Mr. Ditchendorf formerly held the post of process engineer with National Electric. Prior to joining the company in 1958, he was a plant superintendent with the Heltzel Steel Form & Iron Co.

Raymond T. Klempay has been appointed vice president, engineering, of The McKay Machine Co. Mr. Klempay will remain as vice president and general manager of Metal Processing Machine Co., a McKay subsidiary, in addition to his new duties. Mr. Klempay began his career with McKay in 1930 as a design engineer. Six years later he became a general planning design engineer at U. S. Steel Corp., transferring back to McKay in 1938. In 1944, he was elected vice president, engineering, of the Arms-Franklin Corp. In 1952, he left Arms-Franklin to form his own engineering firm,

R. T. KLEMPAY

T. W. MORRISON

H. J. HAUSER

L. H. KARPF

The Metals Processing Machine Co., which, in 1956, became a McKay subsidiary.

Thomas W. Morrison was named director of engineering and research for SKF Industries, Inc. In his new post, Mr. Morrison takes over active direction of the engineering division and research laboratory. Both organizations were under direction of vice president **Gunnar Palmgren,** who is completing nearly 40 years of SKF service as he prepares for retirement. Mr. Palmgren will serve as vice president and special consultant to the president through the end of the year.

Harlan J. Hauser was named manager of field sales, Farrel-Birmingham Co., Inc., to succeed **D. Wheeler Clark.** He has also been appointed to the company's management committee and has been transferred to the general offices in Ansonia, Conn. Mr. Hauser first joined the Farrel organization in Buffalo, N. Y., in 1941 and was transferred to the sales department in Ansonia in 1944. For the past two and one-half years he has been assistant sales manager of the Consolidated Machine Tool Division and sales manager of the Watson-Stillman Press Division at Farrel's Rochester, N. Y., plant.

Lewis H. Karpf has joined The Chas. Taylor Sons Co., as a ceramic engineer assigned to the research and development department. Mr. Karpf was formerly a research assistant at the Tile Council of America Research Center.

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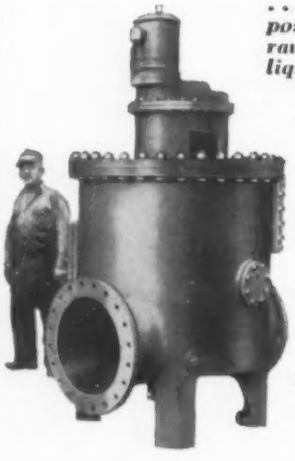
STRAINERS

. . . for efficient removal and disposal of suspended particles from raw or process water and other liquids



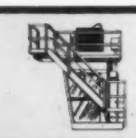
- Over 1000 installations
- 2" to 48" pipeline sizes
- Installation on pressure or suction side of pump
- Over 8 billion gallons per day installed capacity
- Large variety of straining media

• • •

Write today for Bulletin 501.11 and list of installations

S.P. KINNEY ENGINEERS, Inc.
CARNEGIE, PENNSYLVANIA

LINTERN



The Standard in Air Conditioning for Crane Cabs and Mill Pulpits
Over 2,200 Installations
Performance Guaranteed
Ask for Booklet AC-573

Larco, inc.
DISTRIBUTOR OF LINTERN CORPORATION PRODUCTS
ROUTE 20 EAST • PAINESVILLE, OHIO

Call or Write* STAMCO *for...

Slitting and Coiling Lines
Cut-to-Length Lines
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Power Squaring Shears • Automatic Resquaring • Corrugating
Culvert • Steel Mill Equipment

STAMCO, Inc., New Bremen, Ohio

SECO's experienced staff of trained engineers . . . men highly skilled in design and execution . . . are available to assist you in solving all problems

Predictable Performance

you may be experiencing through the use of ordinary Steel Slitting Equipment.

These specialists are at your service to eliminate production (and profit) bottlenecks that are unique to your particular operation and can recommend and design a Custom-Built Slitter to your exact specifications, meeting all your production requirements, with predictable performance. Call or write TODAY.

is yours when you change to

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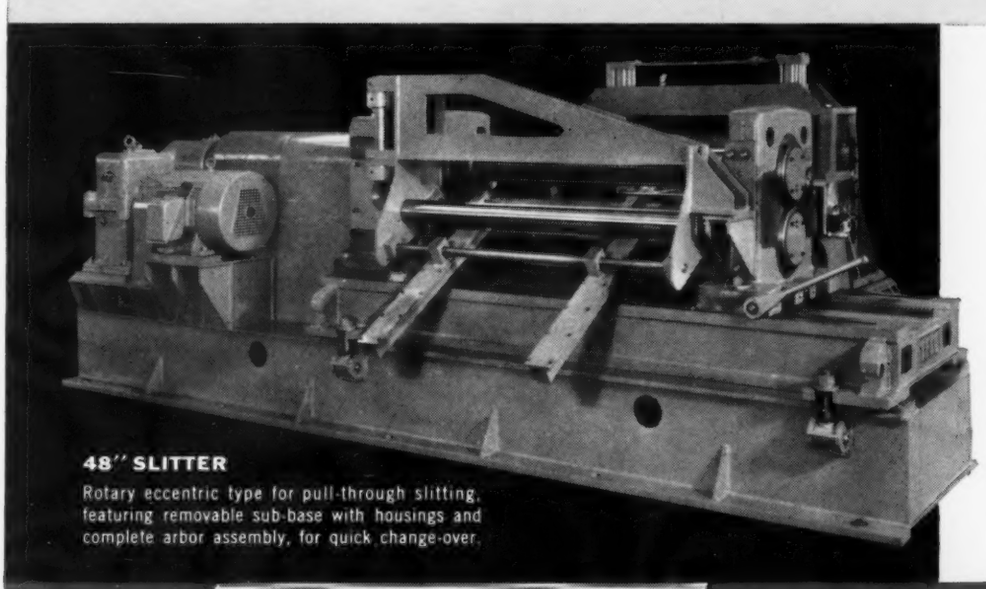
Slitting Lines



48" SLITTER
Rotary eccentric type for pull-through slitting, featuring removable sub-base with housings and complete arbor assembly, for quick change-over.

SECO Steel Mill Equipment

- Leveling and Shearing Lines
- Combination Edging and Flattening Lines
- Tension Reels for Strip Polishers
- Narrow Strip Grinding Machines
- Multiple Strand Pull-out Rolls and Take-up Frames
- Strip Coilers (Up and Down Type)
- Traverse Reels for Narrow Strip
- Steel Coil Up-enders
- Scrap Ballers

SECO

Affiliated with *Lee Wilson* Engineering Co., Inc.

STEEL EQUIPMENT CO.
P. O. BOX 737, WARRENSVILLE STATION
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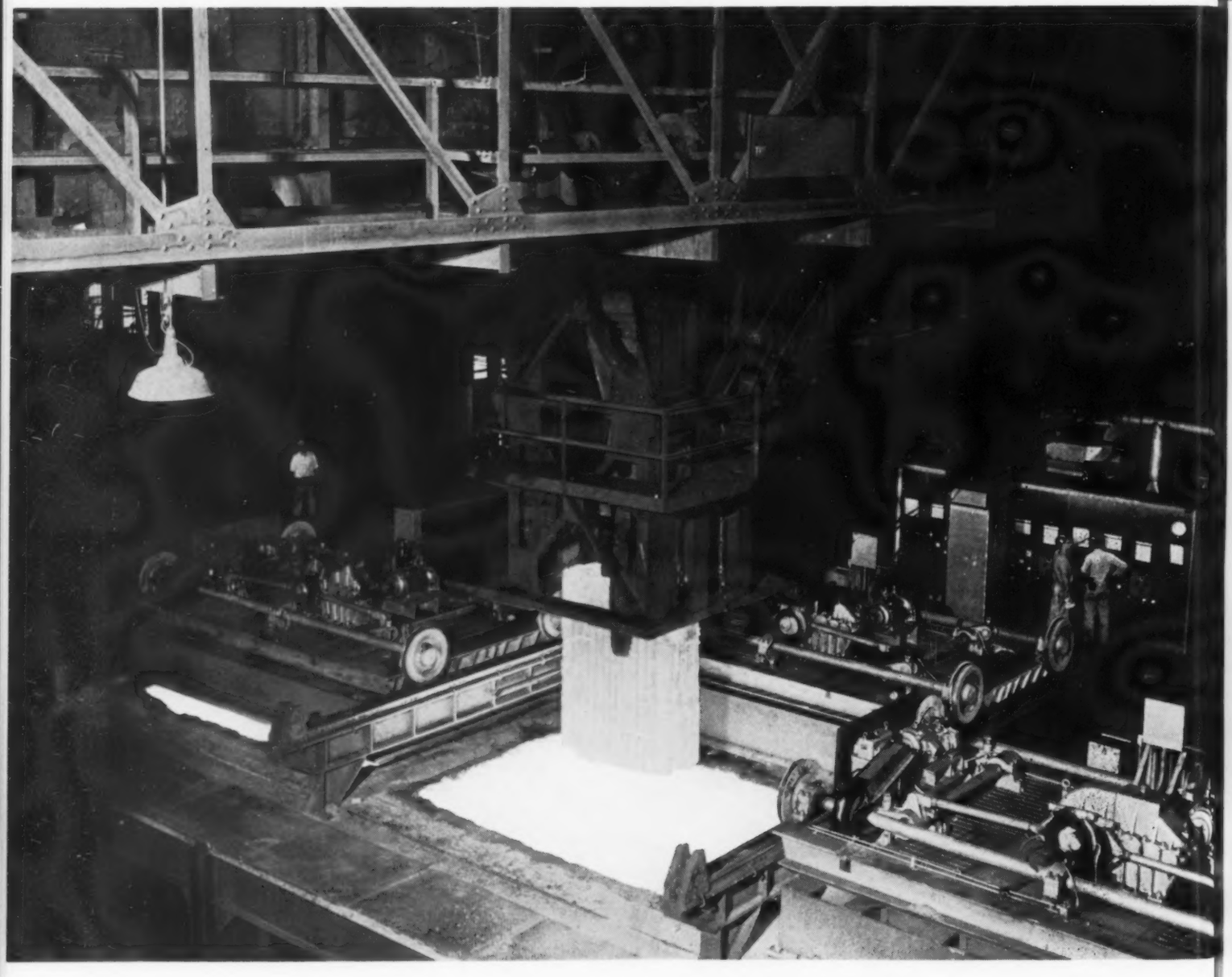
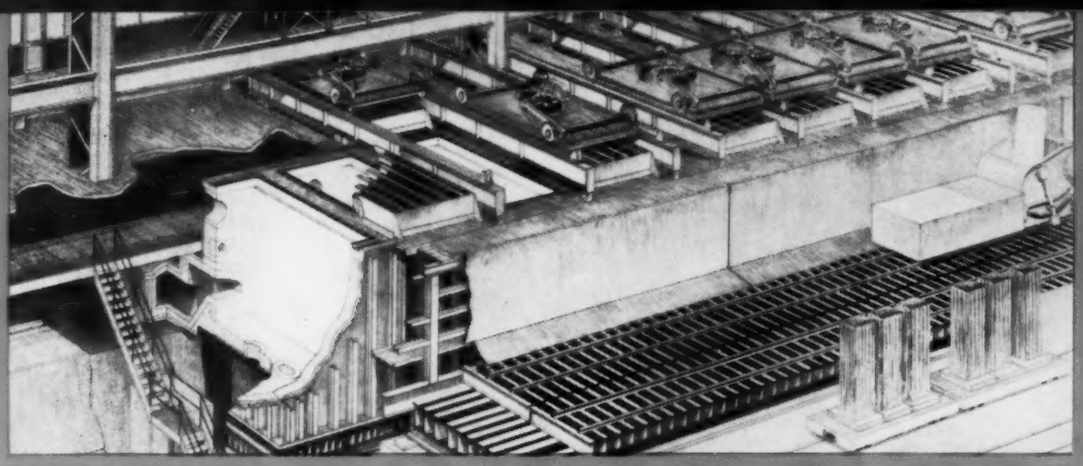
For highest performance requirements . . . on installations of every size

SOAKING PITS

with new features



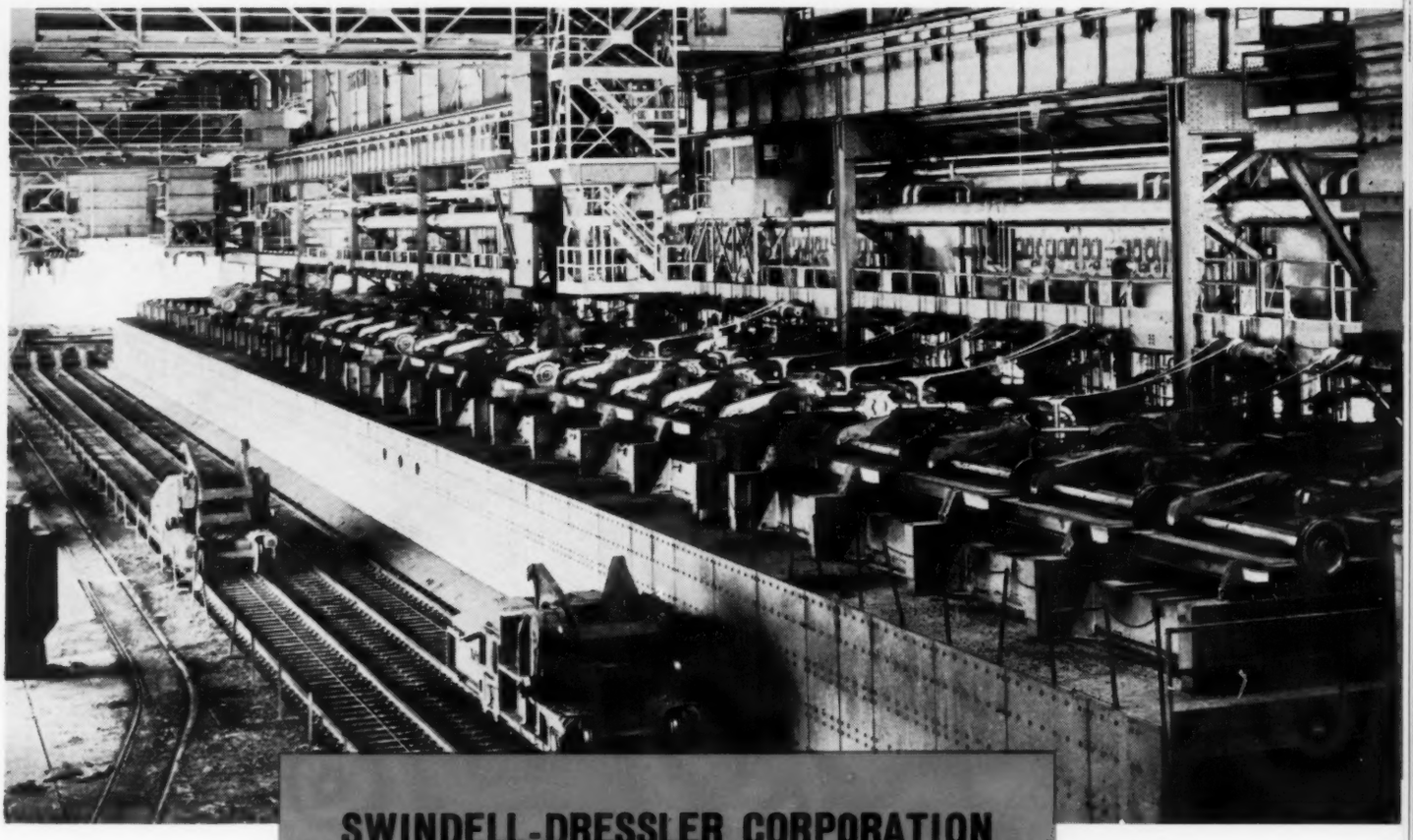
Engineering Service Swindell-Dressler Corporation provides a complete engineering service for the steel industry in the design and construction of new plants, and modernization of existing facilities. Consultations arranged gladly on request.



by SWINDELL-DRESSLER

Swindell-Dressler leadership in furnace design and construction for the steel industry is exemplified fully in our many Soaking Pit installations.

Let us consult with you on the advantages of air at high pressure and temperature, efficient use of blast furnace gas, and outstanding space-saving features . . . all with the well-known rugged Swindell-Dressler construction developed by our many years of steelmill experience.



SWINDELL-DRESSLER CORPORATION

Engineers and Manufacturers

PITTSBURGH 30, PA.

The SWINDELL-DRESSLER CORPORATION of Canada, Ltd.,
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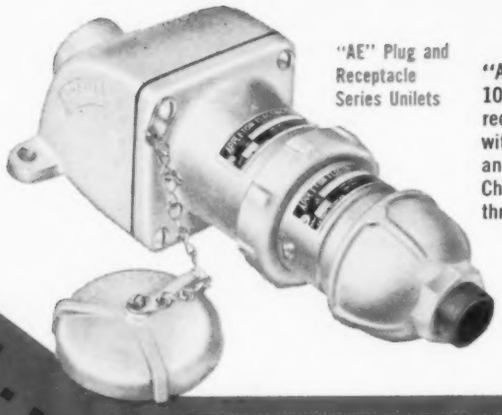
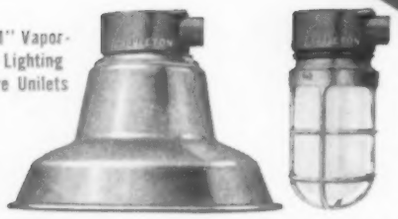
For every need . . .



"AE" Plug and Receptacle Series Unilets

"AE" Series 30, 60, and 100 ampere plugs and receptacles come equipped with solderless connectors and replaceable interiors. Choice of lift cover, or threaded cap types.

"V-51" Vapor-Tight Lighting Fixture Unilets

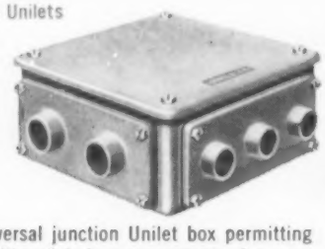


Vapor-tight lighting fixture series for use with rigid conduit. Known for its patented unit construction. Reflector and guard can be put on and taken off quickly . . . without tools! Designed for easy installation plus simple maintenance.

APPLETON®

Malleable Iron UNILETS®

"RS" Series Malleable Unilets



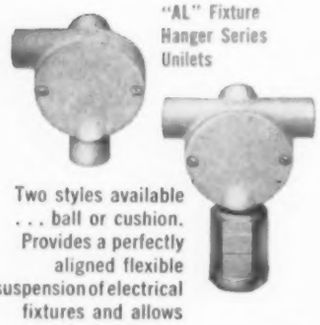
A universal junction Unilet box permitting flexibility of hub arrangements for easy adaptation in the field. Water-tight!

One of the most complete selections in the industry!

Yes, APPLETON can supply you . . . with a wide variety of Unilets for receptacles, switches, plain junctions, pilot lights, fixture hangers, etc. Ample wiring room. Assorted hub arrangements. *You name it, we've got it* . . . for indoors or out.

And every APPLETON product is made to the rigid quality standards pioneered by APPLETON engineers. They are easy to wire, are blemish free, have clean, chamfered threads conforming to N.P.T. requirements assuring a tight joint and positive ground. Next time you buy, specify APPLETON!

"AL" Fixture Hanger Series Unilets



Two styles available . . . ball or cushion. Provides a perfectly aligned flexible suspension of electrical fixtures and allows a swivel to 20° in any direction.

"FS" and "FD" Series Unilets

Weather-proof housings for junctions, receptacles and switches . . . for use outdoors or in. One, two, three and four-gang styles.

Form 35 Series Unilets

Threaded and no-threaded malleable iron series . . . taper threads . . . covers held by screws — will not vibrate loose . . . high quality finish . . . full line.

"JB" Series Vapor-Tight Unilets

With or without mounting lugs. 4 tapped holes and 2 close-up plugs or blank body without close-up plugs. ½", ¾" and 1" sizes for use as "E", "C", "T", or "X" bodies.

Sold Through Franchised Distributors Only

APPLETON ELECTRIC COMPANY
1701 Wellington Avenue · Chicago 13, Illinois

APPLETON ELECTRIC PRODUCTS®

Also Manufacturers of:

Explosion-Proof Lighting Fixtures

"Eagle Claw" Outlet Boxes

"ST" Series Connectors

Reelites

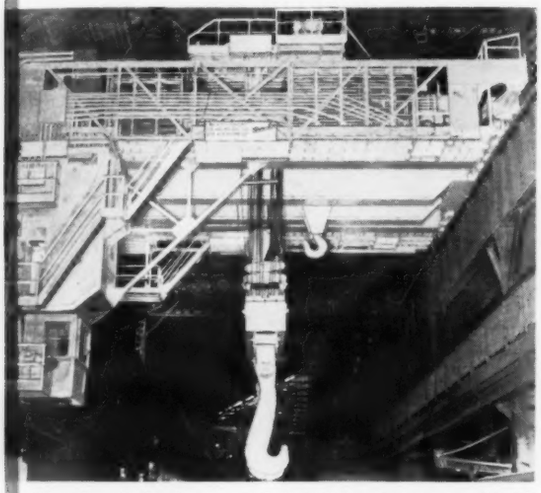
SC Crane speeds outdoor storage. This type of heavy industrial crane is custom built of standardized components. Capacities range from 5 to 40 tons; spans to 120 feet. 3 or 4 motor. Floor or cage operated.

SB Crane on the job in a steel warehouse. This class of standardized crane is built in capacities from 5 to 40 tons; spans to 100 feet. Many built-in "plus values" insure top performance and low operating costs in the severest service.

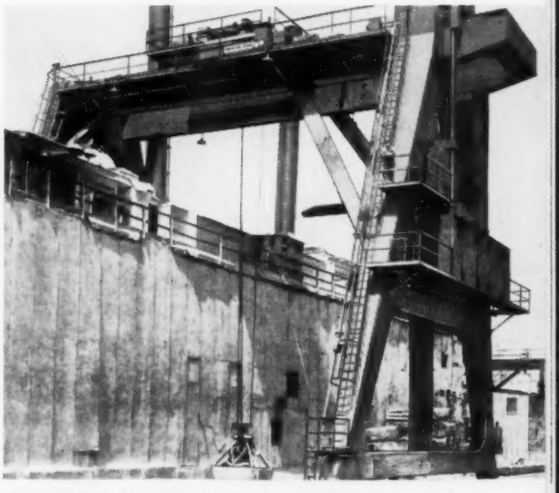
PROOF

of Shaw-Box Crane quality and reliable performance is evidenced by more than 70 years of rapidly growing acceptance from all kinds of industries.

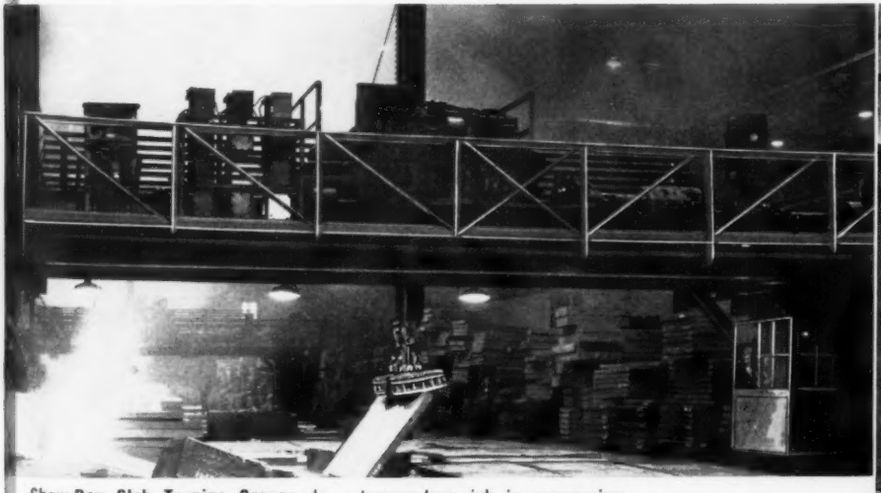
We build all types of cranes to AISE specs or to meet individual standards of structural durability and operational efficiency and economy. Your inquiry is invited.



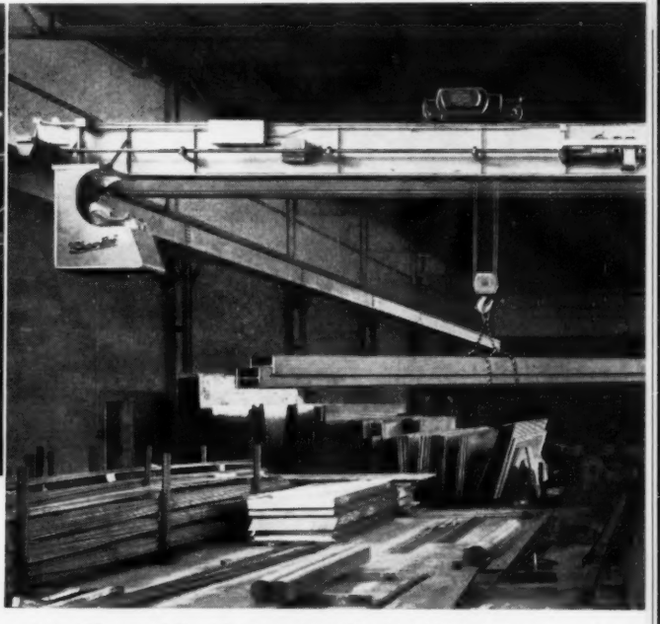
Shaw-Box Ladle Crane. A 4-girder, 9-motor crane with 54 foot span. 90-ton ladle holds 200 tons of molten steel. 75-ton auxiliary trolley handles lighter loads.



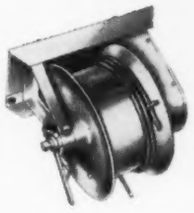
Shaw-Box Bucket Magnet Gantry Crane. Our gantries are serving the steel industry to handle plate, slabs, and scrap. We build them for other industries as well, in any desired capacity.



Shaw-Box Slab Turning Cranes do a tremendous job in conserving manpower and reducing costs around the clock. Rigid, non-whipping construction is combined with the utmost resistance to impacts.



Series "D" Load Lifter Cranes. Capacities to 20 tons, spans to 80 feet. Designed for average industrial service. Components are so highly standardized, you can buy your crane from a catalog.



Soaking Pit Cover Carriages are not only made by Shaw-Box, but we also produce the reliable spring drive cable reels that supply current to the carriages. These reels are also widely used on magnet equipped cranes.

ELECTRIC OVERHEAD CRANE INSTITUTE E.O.C.I. MEMBER

59K-1-A

MANNING MAXWELL & MOORE INC. MM&M TRADE MARK

OVERHEAD CRANES FOR ALL INDUSTRY

Products of

MANNING, MAXWELL & MOORE, INC.

Shaw-Box Crane & Hoist Division • Muskegon, Michigan

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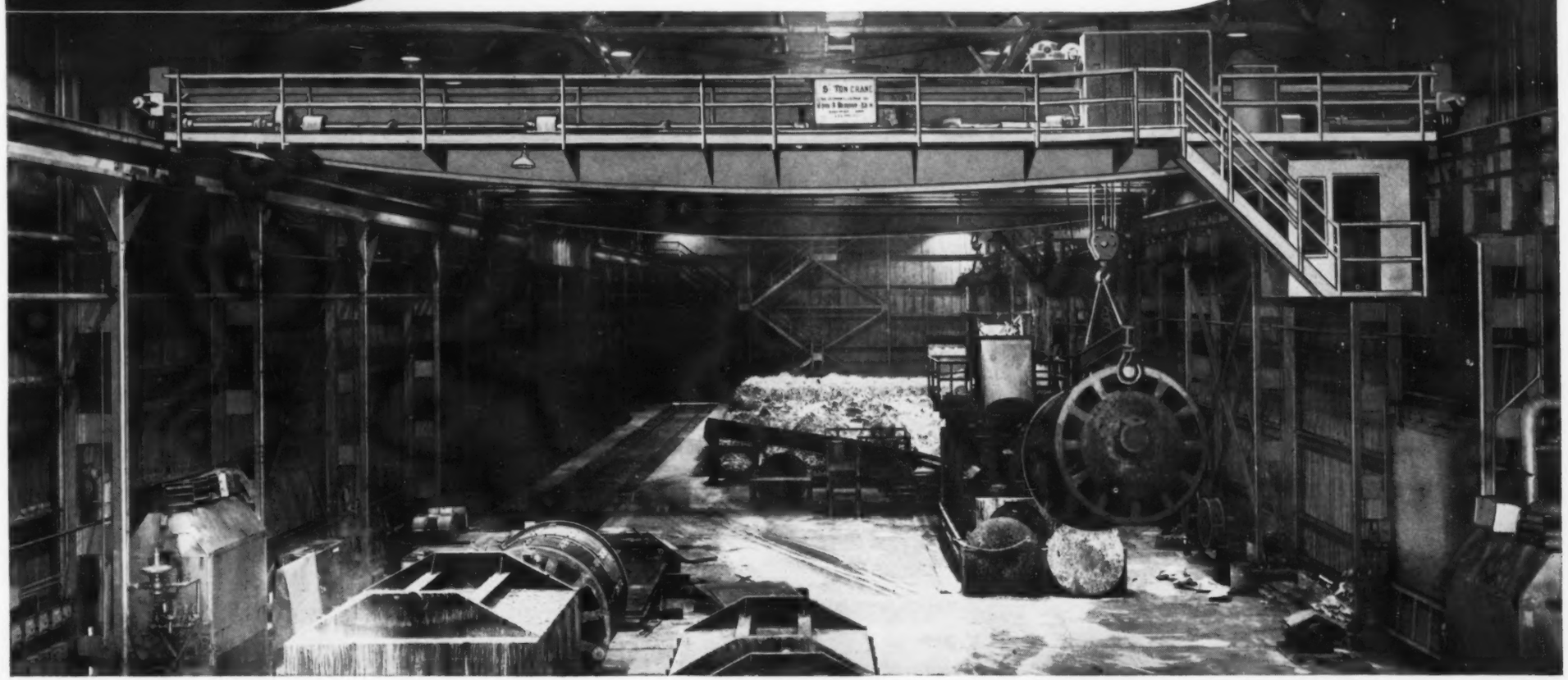
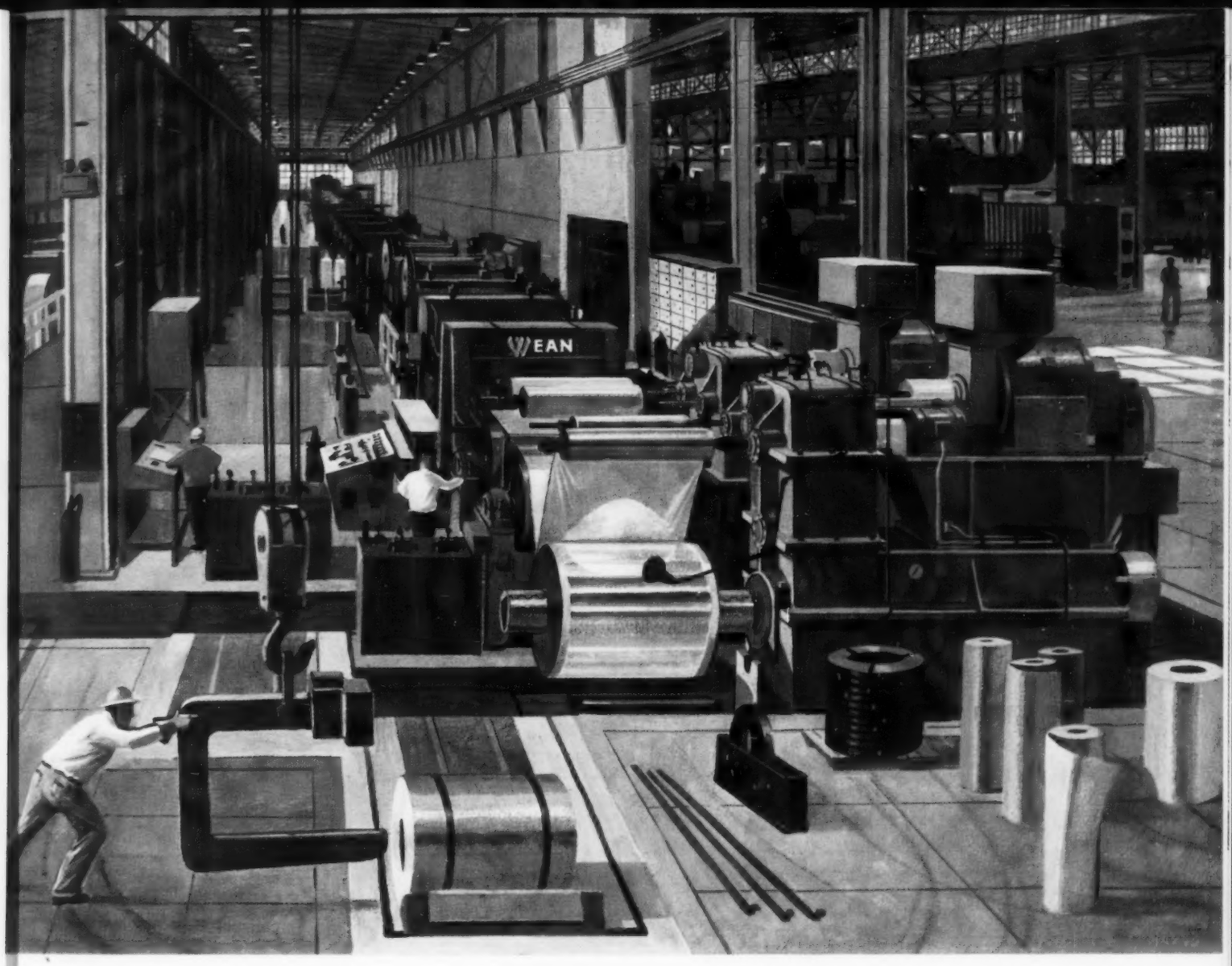
VICTOR R. BROWNING
MILL TYPE CRANES
to Specification...

Basically designed as required by A.I.S.E. specifications, mill type cranes built by Victor R. Browning & Co., Inc. also offer the opportunity of specifying preferences and standards prevailing in the purchaser's plant. May we have your next inquiry?

VICTOR R. BROWNING & COMPANY, Inc.
WILLOUGHBY (CLEVELAND), OHIO
DESIGNERS AND BUILDERS OF ELECTRIC OVERHEAD TRAVELING CRANES AND HOISTS AND ELECTRIC REVOLVING CRANES





Cold rolled anneal and pickle line at Jones & Laughlin Steel Corporation's Louisville, Ohio plant

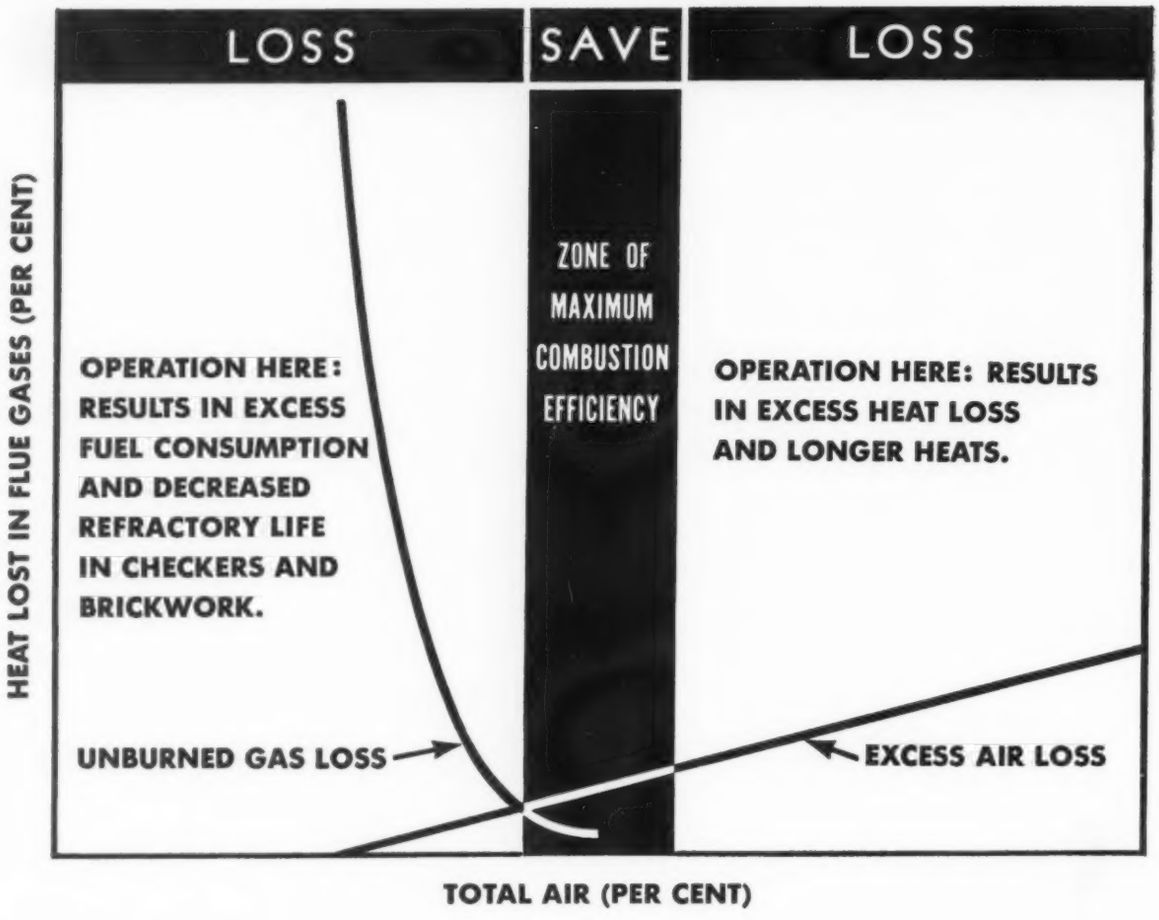
Wean, J&L and Stainless . . .

Eleven continuous processing lines at Jones & Laughlin's impressive new stainless plant—*all designed and built by Wean Engineering*—demonstrate the versatility of Wean's abilities in this field. From conditioning of incoming coil, through annealing, pickling and surface treatment, to slitting and cut-up, these Wean lines assure Jones & Laughlin customers top quality stainless strip or sheet to meet the most exacting requirements.

In the design of this equipment, high quality surface finish of the stainless was a prime requisite—one of the reasons Wean was selected to engineer and build this multi-line installation. Whatever *your* requirements in continuous strip processing, you can benefit from Wean's *creative engineering*.

THE WEAN ENGINEERING COMPANY, INC. • WARREN • OHIO

To Save Fuel . . . Analyze for Combustibles, Too . . .


LOSS
SAVE
LOSS
ZONE OF MAXIMUM COMBUSTION EFFICIENCY
OPERATION HERE: RESULTS IN EXCESS FUEL CONSUMPTION AND DECREASED REFRACTORY LIFE IN CHECKERS AND BRICKWORK.
OPERATION HERE: RESULTS IN EXCESS HEAT LOSS AND LONGER HEATS.
UNBURNED GAS LOSS
EXCESS AIR LOSS
HEAT LOST IN FLUE GASES (PER CENT)
TOTAL AIR (PER CENT)

Standard Steel Works finds oxygen and combustibles analysis saves fuel; gives closer control of open hearths.

Results—Fuel conversion was completed without firing difficulties . . . and closer supervision of open hearth operation from a fuel-air ratio standpoint was realized. These were immediate results reported by Standard Steel Works Division of Baldwin-Lima-Hamilton Corporation, Burnham, Pa.

Oxygen and combustibles on same chart

The conversion from oil to oil-natural gas firing was tried first on one of five open hearths. Continuous analysis of combustion gases was added at the same time. The Bailey Analyzer-Recorder played a dual role in training operators, and giving engineers a fast check on the efficiency of the firing system.

Big Help—Part of the credit for success of the changeover goes to the gas analysis system. Here's why—

1. It measures the percentage of oxygen in the flue gas, which indicates the excess air loss.

2. It measures the percentage of combustibles in the flue gas, which is a check on the mixing efficiency of the burners.

3. It provides a continuous and permanent record of both variables on one chart, which, in addition serves as an operator's guide.

Money's Worth—The gas analysis system has been trouble free from the start (July 1957). Operators quickly mastered the technique of oil-gas firing with the help of the analyzer charts. Pleased with the results, Standard Steel Works is installing the same system on its four other open hearths.

Write for Performance Report OH11-1 for complete details on this installation. S12-1

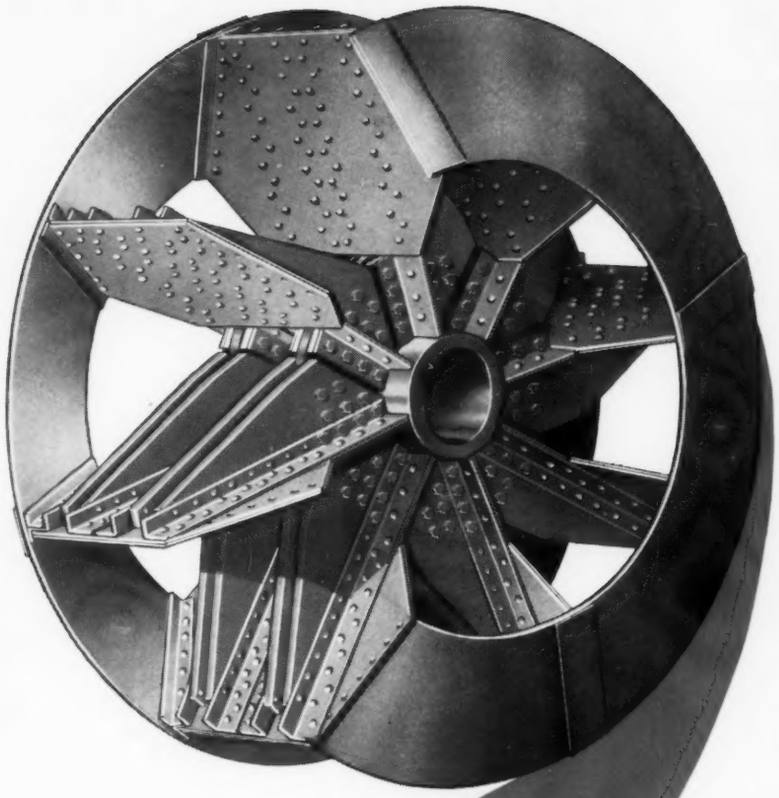
IRON AND STEEL DIVISION

BAILEY METER COMPANY

1047 IVANHOE ROAD • CLEVELAND 10, OHIO

In Canada—Bailey Meter Company Limited, Montreal

BAILEY METERS



Here's a rugged giant of a fan for sintering!

Green *Sintering Fans*

Specially Developed To Withstand Punishing Everyday Operation

This fan won't punch a time clock! The heavy duty battleship construction and extreme erosion resistance assures you dependable service and *longer life*.

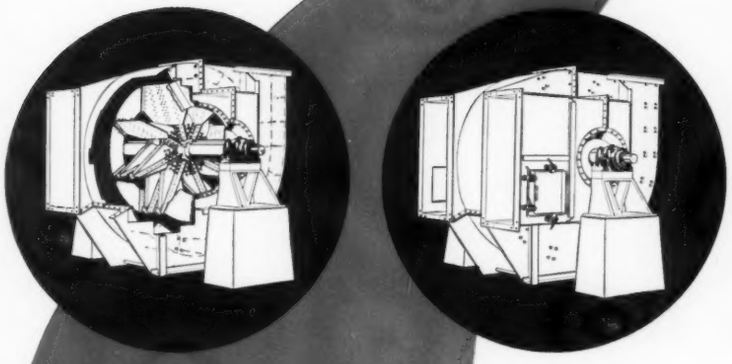
CUSTOM ENGINEERED: No Green Sintering Fan is a stock fan. Each Green Sintering Fan is specifically designed and engineered to meet your particular requirements.

Careful stress studies of every cubic inch of material in a Green Fan are made to meet the tip speeds of 30,000 fpm, or more, necessary for pressures required in sintering.

EROSION RESISTANT: Erosion of fan blades is a serious and ever present sintering problem. Green Fans are designed to keep necessary maintenance time and expense to a minimum. With unique blade design and thick blade liners, erosion problems are drastically lessened. Green blade liners, incidentally, may be replaced without the removal of the rotor.

BUILT-IN SAFETY: Green Sintering Fans are designed to limit operating speed to 66⅔% of first critical speed. Material safety factor at operating temperature is never under 2.

Green custom designed Sintering Fans offer you minimum annual expense and maximum dependability. Write for information and details.

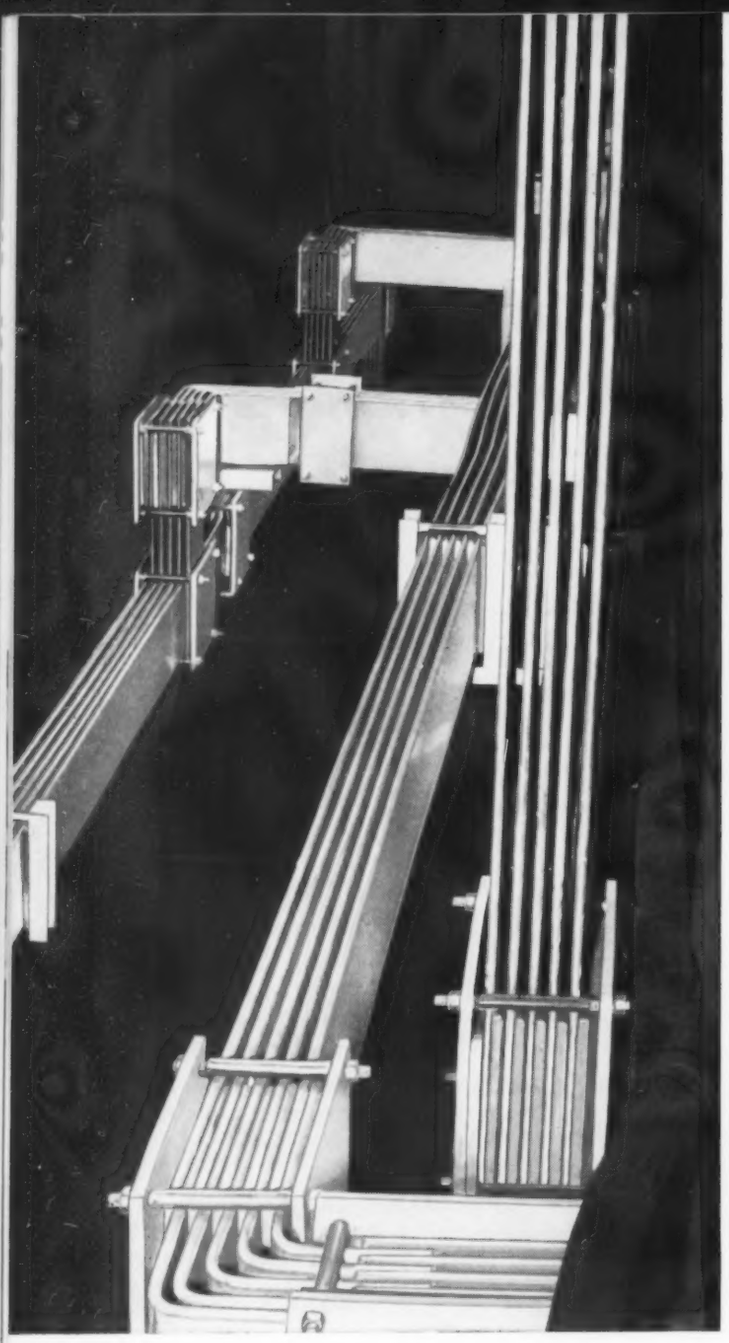


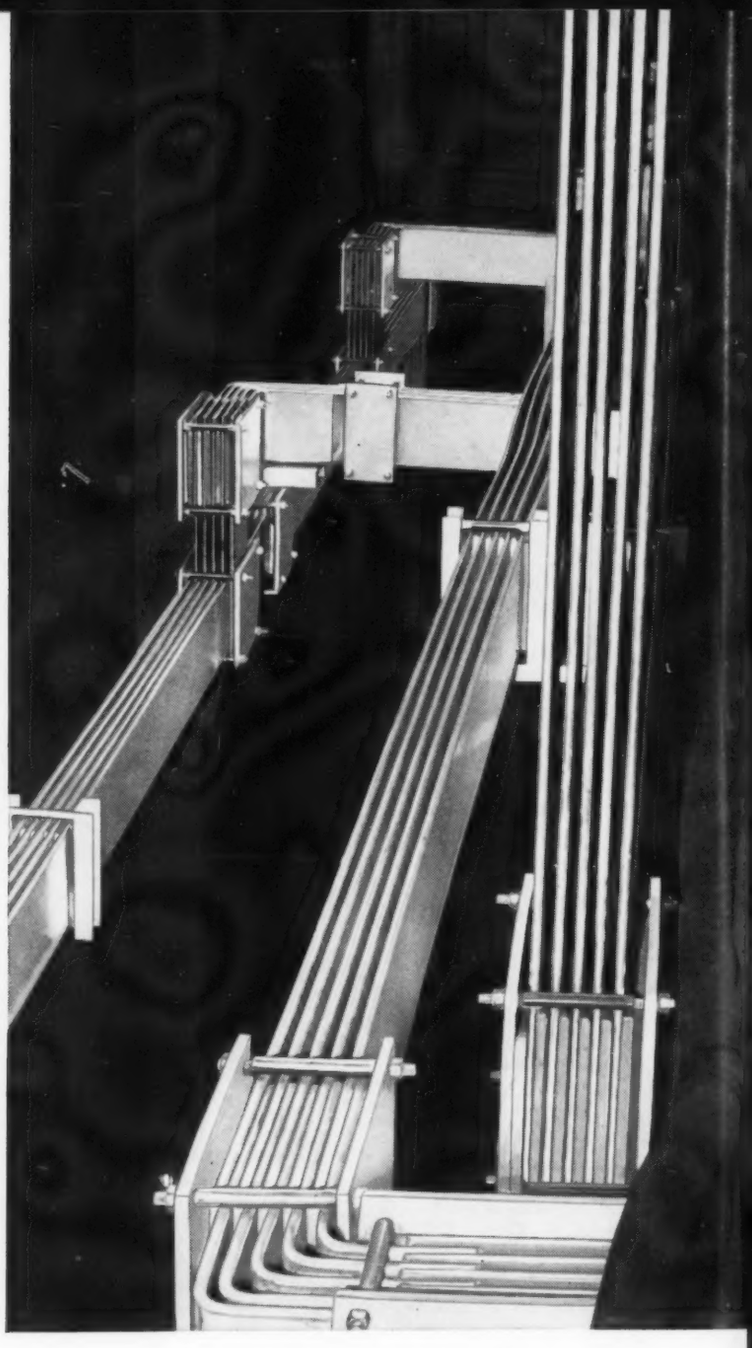
A major steel producer has installed six of these Green Sintering Fans. Each fan produces 360,000 cfm at 35 in. static pressure at 360° F.

Green

THE GREEN FUEL ECONOMIZER CO., INC.

BEACON 3, NEW YORK





WITH ALCOA ALUMINUM BUS CONDUCTOR...

twice as much for the same price

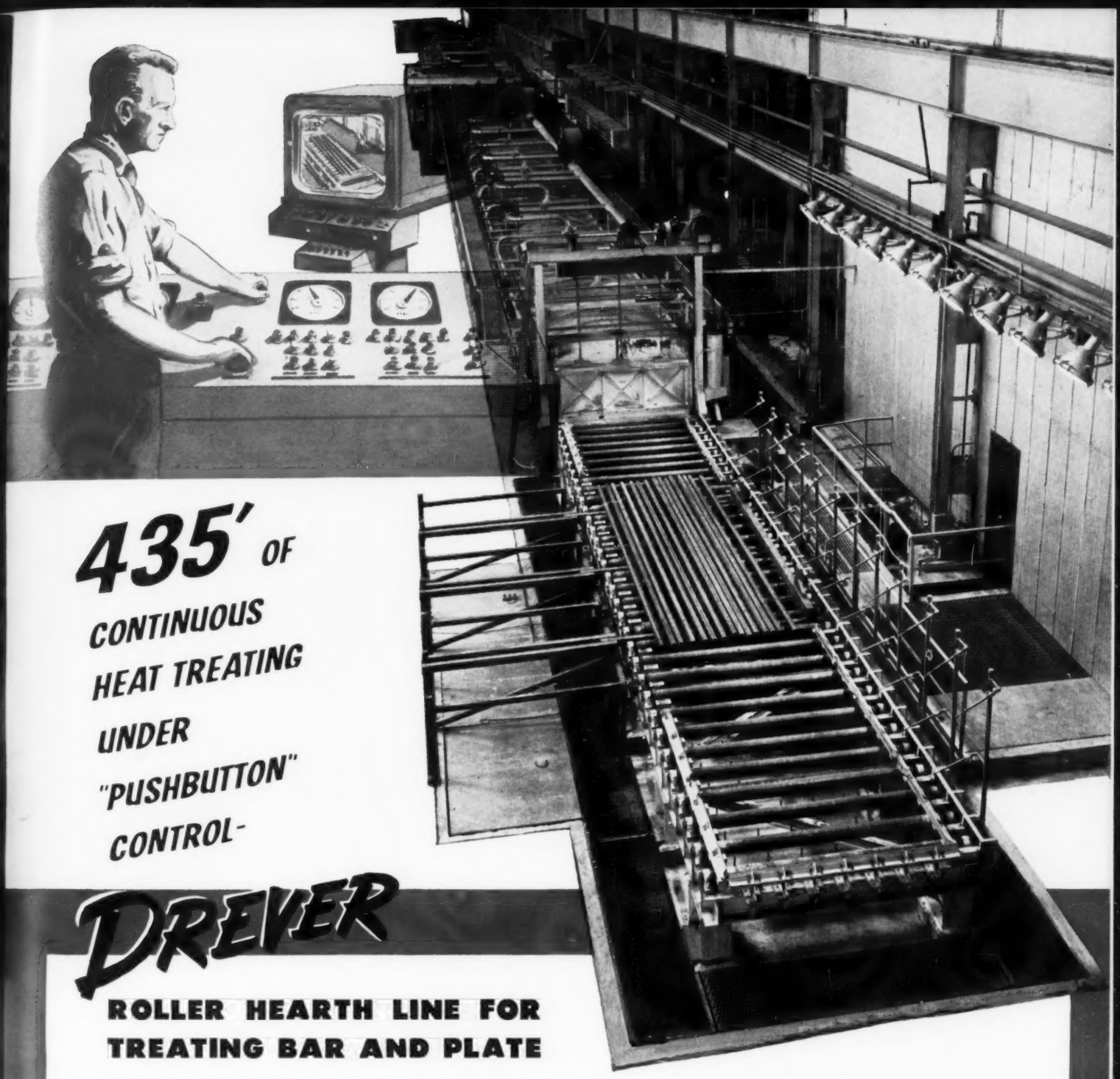
IT'S TRUE—for conductors with the *same* electrical and heat-dissipating ratings, you can buy, today, *two* feet of Alcoa bus for the price of just *one* foot of copper.

BUT MATERIAL cost is only part of the story. Lightweight Alcoa® Aluminum Bus Conductor handles more easily and requires less costly supporting structures. It's easier to bend and form to your needs. Millions of pounds of aluminum bus are in service today in all types of industry.

SO WHY ever use *any* bus except Alcoa Aluminum? There's not a reason in the world . . . not these days! For up-to-date facts and figures on how much *you* can save, call Alcoa or your Alcoa Distributor. Aluminum Company of America, 2113-K Alcoa Building, Pittsburgh 19, Pennsylvania.

Write on company letterhead for *Alcoa Aluminum Bus Conductor Handbook*

ALCOA ALUMINUM



435′ OF CONTINUOUS HEAT TREATING UNDER "PUSHBUTTON" CONTROL-

DREVER

ROLLER HEARTH LINE FOR TREATING BAR AND PLATE

The Drever Roller Hearth Line provides the higher output to be expected from continuous production but at the same time adds ease of operation, versatility, and uniformity of quality. Engineered as a complete coordinated unit, it hardens, quenches and tempers twelve 6" dia. x 40' long bars at a time with maximum production rate of 30,000#/hr. It can also be used to normalize carbon steel plate up to 72" wide x 40' long at a rate of 19,000#/hr.—or heat alloy steel plate to 1650°F with controlled cooling to 1300°F at a maximum rate of 9,500#/hr.

The entire operation from charge to discharge is directed from an air conditioned booth which utilizes television monitoring and radio intercommunication from booth to floor.

The rolls of each unit have separate drives—maximum line speed is 200 fpm, variable to a low of 0.3 fpm in the tempering furnace.

Like all Drever Heat Treating Units, the Roller Hearth Lines are engineered to be an important part of the modernization of metals production processes—and are the result of specialization since 1939. Write or phone us about your heat treating requirements.

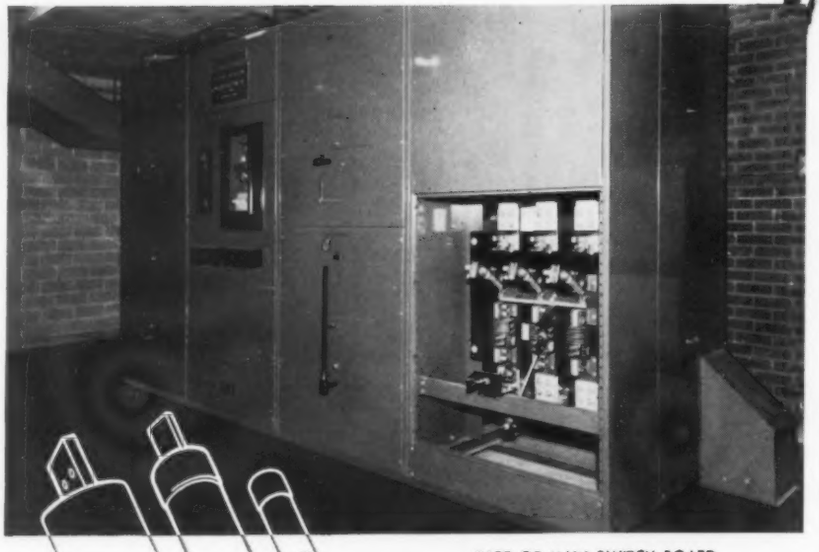
DREVER COMPANY

BETHAYRES, PA.

Phone: Wilson 7-3400

Electrical Protection is MODERNIZED with BUSS Fuses in the

TAMPA CITY HOSPITAL
Tampa, Florida



PART OF MAIN SWITCH BOARD
Protected by BUSS Hi-Cap and FUSETRON fuses.
Installation includes 6—2500 amp., 3—2000 amp., 12—1200 amp., 9 — 800 amp. BUSS Hi-Cap fuses . . . . . and 3—600 amp., 9—400 amp., 27—200 amp. FUSETRON fuses

In this beautiful hospital, tremendous in size, it was found necessary to increase the capacity of the electrical system to meet today's requirements. Modernization of the electrical system resulted in estimated available fault currents of 150,000 amperes.

With faults of this magnitude possible, it became essential that a superior type of protective device be used.

So in the main switch board are BUSS Hi-Cap fuses and FUSETRON dual-element fuses, both applied to give the interrupting capacity and dependability needed on the circuits they protect.

ANOTHER BUSS HI-CAP AND FUSETRON FUSE INSTALLATION

ARCHITECTS AND ENGINEERS: *Norman F. Six and Elliot C. Fletcher, Tampa and Schmidt, Garden and Erikson, Chicago*

CONTRACTOR: *Miller Electric Co., Jacksonville, Fla.*

WHY HIGH INTERRUPTING CAPACITY IS NEEDED

Fault currents of 75,000 or 150,000 amperes were unheard of a few years ago, — but today they are quite possible. With the generating capacity of utilities increasing yearly, most likely the magnitude of fault currents will be higher in future years.

BUSS Hi-Cap and FUSETRON dual-element fuses have an interrupting capacity designed for today's conditions and to anticipate system growth.

The interrupting rating of BUSS Hi-Cap fuses is 200,000 amperes rms symmetrical — and for FUSETRON fuses it is 100,000 rms symmetrical.

WHY DEPENDABILITY IS NEEDED

With higher fault currents available, the dependability of the protective device becomes of increasing importance.

The protective device should be just as accurate in 10, 15, or 20 years, as it is on the day installed.

A fuse is the only type of protective device to offer this advantage. A fuse must remain safe and accurate, as its operation depends on a simple thermal law. A fuse has no triggers, latches, pivots or contacts to stick or get out of order. Dust, fumes, corrosion or age cannot increase a fuse's capacity or lengthen its blowing time.

for more information

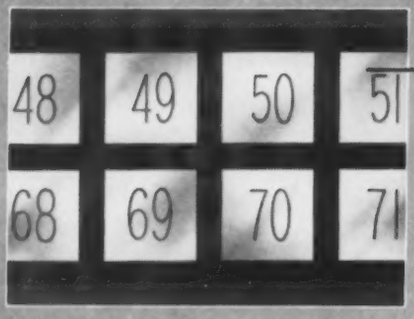
On FUSETRON dual-element fuses - (loads of 0 to 600 amps.) - ***write for bulletin FIS***

On BUSS Hi-Cap fuses - (loads above 600 amps.) - ***write for Bulletin HCS***

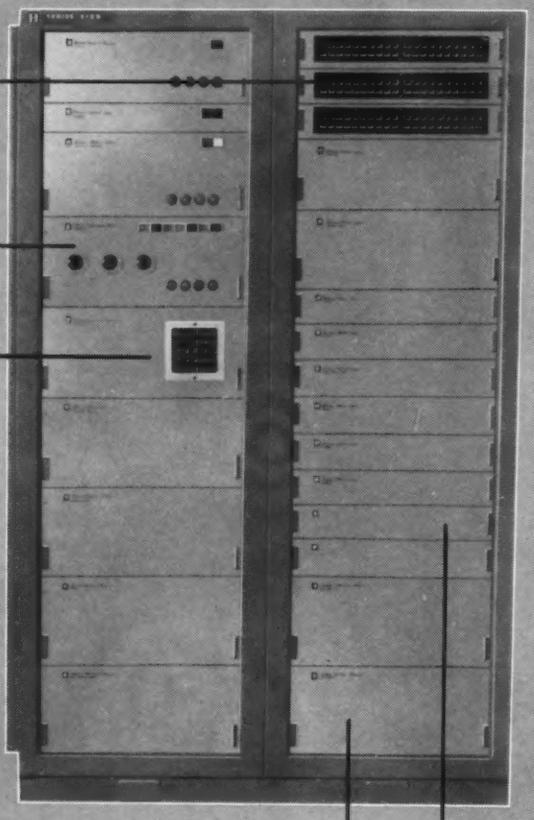
959

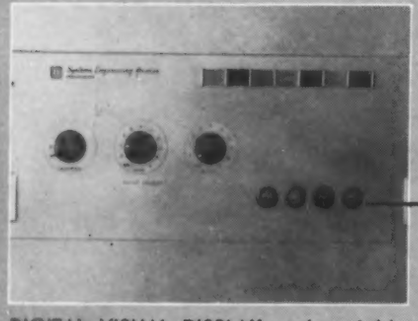
BUSSMANN MFG. DIVISION, McGraw-Edison Co. **ST. LOUIS 7, MO.**

New packaged

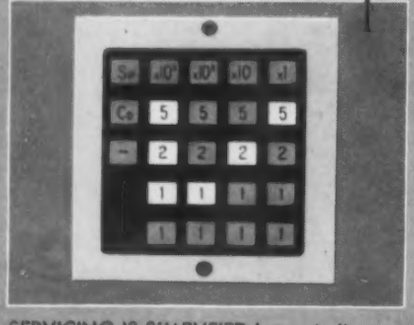


THREE 40-POINT ANNUNCIATORS make it easy for the operator to tell at a glance which variables are off-normal.

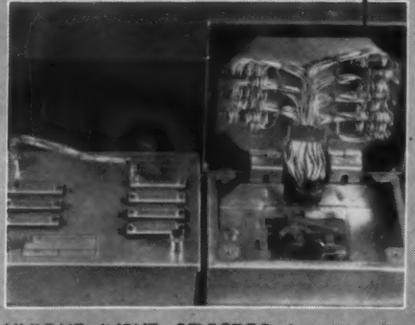




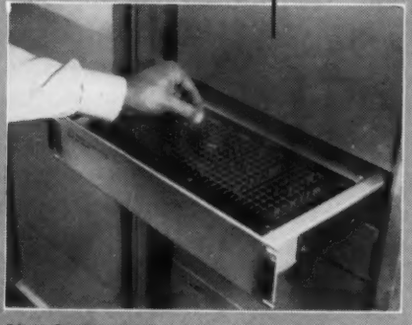
DIGITAL VISUAL DISPLAY and variable selector switches make it easy to select any single variable and watch all trends and changes continuously.



SERVICING IS SIMPLIFIED by an indicator-light panel showing the completion of each step in the analog to digital conversion. The sequence programmer can be changed from automatic to hand advance to permit operator to check each step.



UNIQUE INPUT SELECTOR is unusually dependable because of its sealed, oil-immersed construction. Servicing is normally limited to visual inspection every 6 months. Drawers pull out so voltage checks can be performed without shutting down system.



PINBOARD PROGRAMMING adds flexibility. You can change the logging or scanning sequence at will . . . substitute one type of input for another. Range, span, and zero adjustment are set by inserting pins in their proper places. No calculations are required. The pinboards are pinned in familiar units of measurements.

Honeywell logger-scanner

...accurate within ± 0.1% of reading

...pinboard programming for maximum flexibility

Here's a standard, all-purpose 120-point logger-scanner system with features formerly found only in more expensive, custom-designed equipment . . . the first of several packaged logger-scanners being introduced by Honeywell. It offers the ultimate in accuracy, flexibility, dependability and simplicity of maintenance. Wide ambient temperature operating limits—60 to 120°F—eliminate the need for special air conditioning equipment.

The Series 3120 accepts signals from primary measuring instruments—thermocouples, flow, pressure or other transducers. It measures these signals, digitizes them, and prints their values in immediately usable form. A thermocouple reference oven can be supplied to accommodate three types of thermocouple inputs—types T, J, and K—which are automatically linearized over their entire range to within 0.1% accuracy.

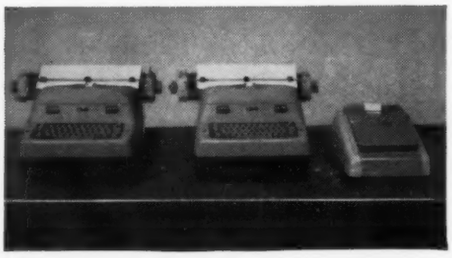
The operator can select either automatically or manually initiated logging cycles. He can set the system to log all variables automatically at preset intervals, or manually energize the system to operate on demand, between logging cycles.

Between logging cycles, the system can scan off-normal alarm points—high, low or both—at a rate of 7 points per second. Upon detecting an off-normal point, the system sounds an alarm, lights a point-identification light, and prints the time, point number and off-normal value on adding machine tape. During log cycles, off-normal points are printed in red on the log sheet.

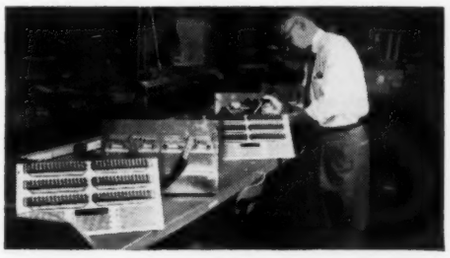
Get complete details from your nearby Honeywell field engineer. Call him today . . . he's as near as your phone. MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.

Honeywell

H HONEYWELL *First in Control*



TWO TYPEWRITERS permit a single line log allowing columnar comparisons. Separate alarm printer records all off-normal variables.



STANDARD MODULAR COMPONENTS are assembled on chassis mounted as individual drawers in relay racks. All drawers are connected by plugs for easy servicing.

Machinecraft gets .0005" tolerances with Cities Service Chillo Cutting oils!

Machinecraft, Inc., of Whitman, Massachusetts, makes a product that is surely the answer to many a textile man's fondest wish.

In place of old-style solid arbor top rolls, which often drip lubricant onto the fabric, Machinecraft has developed "the anti-friction top roll."

Operating on ball bearings, this unique invention requires almost no lubrication, therefore eliminates staining problems. In addition, it permits higher speeds of operation and produces more uniformly woven fabric.

In all of this, extremely intricate machining is required —and Cities Service Chillo Cutting Oil plays a crucial role.

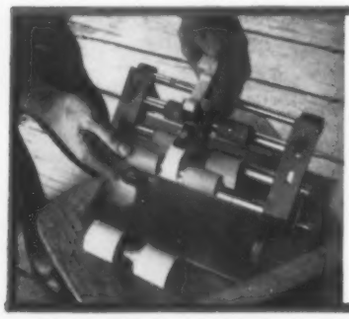
Using Cities Service Chillo "A," Machinecraft is actually achieving tolerances as fine as .0005"! Moreover, Machinecraft reports that Chillo "A" gives "excellent tool life, produces a fine finish, has unusual stability, and offers continuous quality from batch to batch."

"In addition," continues this well known firm, "Cities Service provides us with exceptional technical assistance and good delivery service."

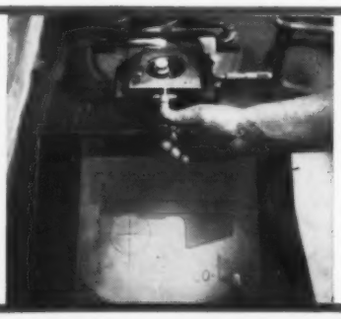
There's little to add to what Machinecraft says except a reminder that *you* can expect similar results with Cities Service, too. Talk with a lubrication engineer from the nearest office. Or write: Cities Service Oil Company, Sixty Wall Tower, New York 5, N. Y.

CITIES SERVICE

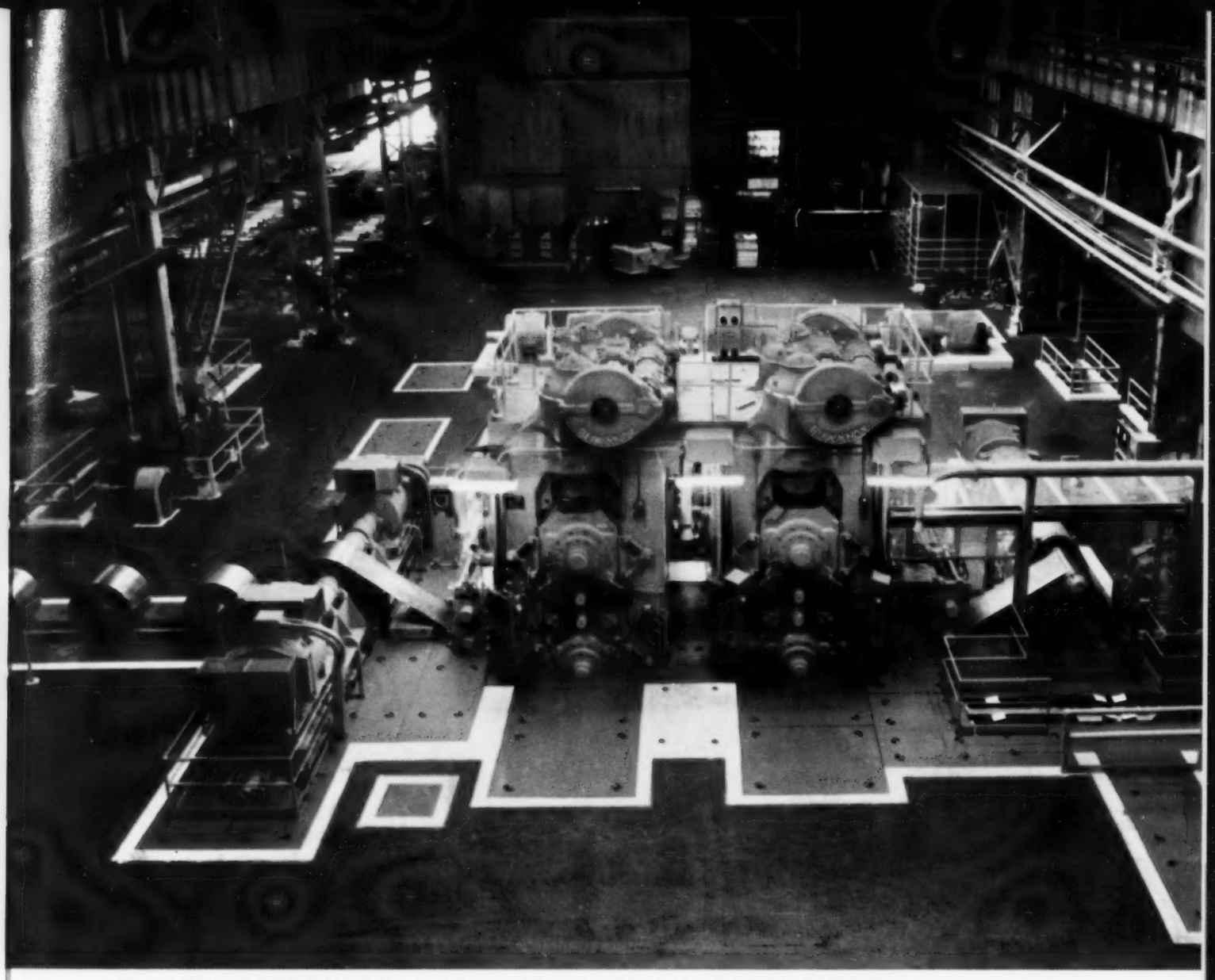
QUALITY PETROLEUM PRODUCTS



Machinecraft's Anti-Friction Top Roll is rapidly replacing old-style solid arbor type top rolls in textile mills. It prevents staining, permits greater operating speeds.



Shadowgraph is method of checking accuracy of precision machined parts for anti-friction top roll. Machine magnifies and projects the part's shadow outline. Tolerances are as fine as .0005".



19- and 53-inch x 48-inch high speed 2-stand Temper Mill at the Fairfield, Alabama, works of the Tennessee Coal and Iron Division of the United States Steel Corporation.

BLAW-KNOX TEMPER MILLS

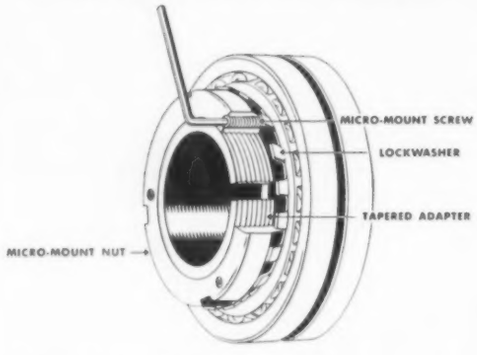
Blaw-Knox designs and builds a full range of two high and four high Temper Mills for integration into sheet, strip, and tin plate processing operations. Other Blaw-Knox equipment for the metals industry includes complete rolling mill installations and auxiliary equipment for ferrous and non-ferrous metals, sheet and strip processing equipment, electrolytic tinning, annealing, and galvanizing lines, seamless pipe and tube mills, draw benches, and cold draw equipment, Blaw-Knox Medart cold finishing equipment, iron, alloy iron and steel rolls, carbon and alloy steel castings, fabricated steel plate or cast-weld design weldments, steel plant equipment, and heat and corrosion resisting alloy castings.

BLAW-KNOX

BLAW-KNOX COMPANY

Foundry and Mill Machinery Division
Blaw-Knox Building • 300 Sixth Avenue
Pittsburgh 22, Pennsylvania

Exclusive MICRO-MOUNT



Fast and accurate mounting is made possible by the new Dodge Micro-Mount. The Adapter is snugged up with the Micro-Mount Nut. Mounting is completed by turning the Micro-Mount Screws against the Lockwasher until bearing, adapter and shaft form an integral unit.

NEW!

Spher-Align

SPHERICAL ROLLER BEARING PILLOW BLOCK

Dodge, the nation's leading supplier of mounted bearings, presents America's newest spherical roller bearing pillow block . . . a rugged bearing in attractive modern design . . . inherently self-aligning . . . easy to install . . . easy to maintain . . . and featuring the unique Micro-Mount.

Its rugged housing of close-grained semisteel withstands shock loads. It has a generous lubrication reservoir—for oil or grease. And standardized dimensions make Spher-Align interchangeable with all other similar units.

Expansion and non-expansion types. Stocked for 2 7/16" to 8" shafts. Call your Dodge Distributor—or write us.

DODGE
of Mishawaka, Ind.

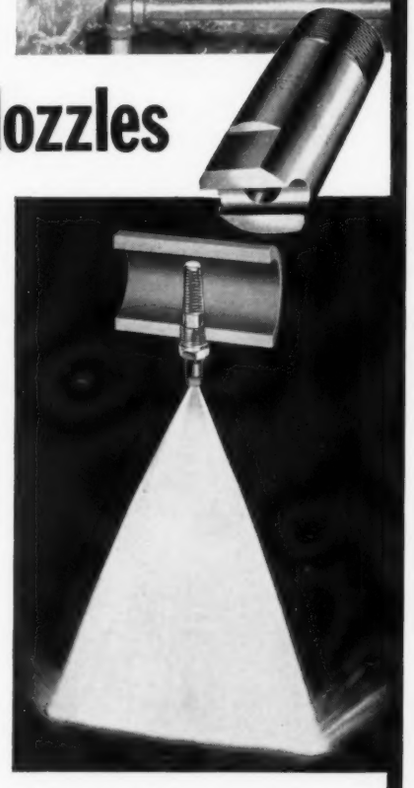
CALL THE TRANSMISSIONEER, your local Dodge Distributor. Factory trained by Dodge, he can give you valuable help on new, cost-saving methods. Look in the *white* pages of your telephone directory for "Dodge Transmissioneer."

DODGE MANUFACTURING CORPORATION
5900 Union Street, Mishawaka, Indiana

every installation a complete success

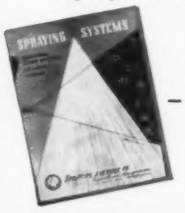
with Spraying Systems Co.

Spray Nozzles



for hot strip spray cooling descaling roll cooling and related operations

● Greater spraying efficiency and lower equipment and maintenance costs are the advantages Spraying Systems Co. spray nozzles give you. Nozzles for hot strip cooling for example, give better steam barrier penetration and spray distribution . . . remove more heat per minute per gallon of water. Descaling nozzles provide greater impact for any volume and pressure without excessive cooling. Non-clogging design and recommended types of mounting are features that help reduce maintenance costs. Your inquiry is cordially invited for Spraying Systems Co. spray nozzle data and application information.

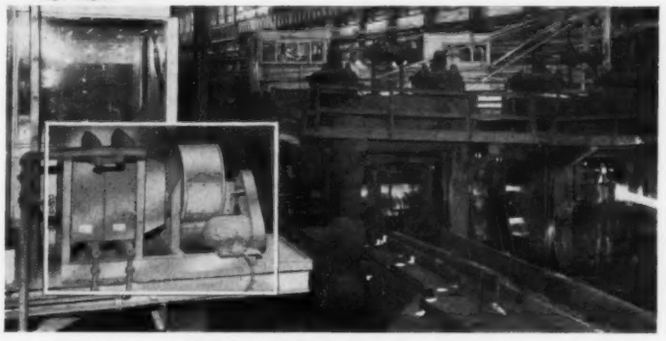


SPRAYING SYSTEMS CO.
3262 RANDOLPH STREET • BELLWOOD, ILLINOIS

For information on Spray Nozzles and Steel Mill Applications write for Catalog 24 and Supplementary Data Sheets.

PROBLEM!

Prevent
OIL AND WATER LINE FREEZING AT GROUND LEVEL AROUND ROLL STAND FOOTINGS.



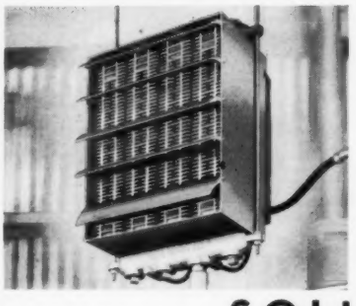
One of Three Grid High Velocity Blower Units installed in Inland Steel's Plant #2-28" Mill Building.

SOLUTION!

GRID HIGH VELOCITY HEATING UNITS consisting of all cast iron Blast Heaters with belt driven, high speed blower. These special units operate on 150 P.S.I. steam pressure at 450 degree Fahr. temperature. Air is raised from 10 to 20 degrees at inlet side to 150 degrees at discharge. Air discharge nozzles located below the platform force heated air in downward, angular direction to ground level. Air velocity 2500 to 2700 F.P.M. Air volume 4100 C.F.M.

PROBLEM!

USE STEAM FOR COMFORT HEATING THROUGH UNIT HEATERS IN SINTERING PLANT. STEAM SERVICE 225 P.S.I. PRESSURE REDUCED TO 75 P.S.I., 600 DEGREE TEMPERATURE WITH 300 DEGREE SUPER HEAT.



One of 62 High Test Cast Iron Grid Unit Heaters installed in Inland Steel's Sintering Plant, East Chicago, Ind.

SOLUTION!

GRID special alloy HIGH TEST cast iron Unit Heaters. Alloy iron heating elements and top and bottom headers designed to withstand 75 P.S.I. steam pressure with 300 degree super heat. All parts subject to pressure are made for maximum of 225 P.S.I., in event reducing valves fail. Motors are equipped with special insulation and heat stabilized bearings. Fans are arranged with heat shields to reflect radiant heat.

FOR MAINTENANCE FREE HEATING SERVICE AND FOR THAT DIFFICULT STEEL MILL HEATING PROBLEM, SPECIFY GRID CAST IRON UNIT HEATERS, BLAST HEATERS AND RADIATORS.

Engineering consultation service without obligation. Write for catalog 956, the complete Grid Story.

Manufacturers Since 1883

GRID D. J. MURRAY MANUFACTURING CO.
WAUSAU, WISCONSIN

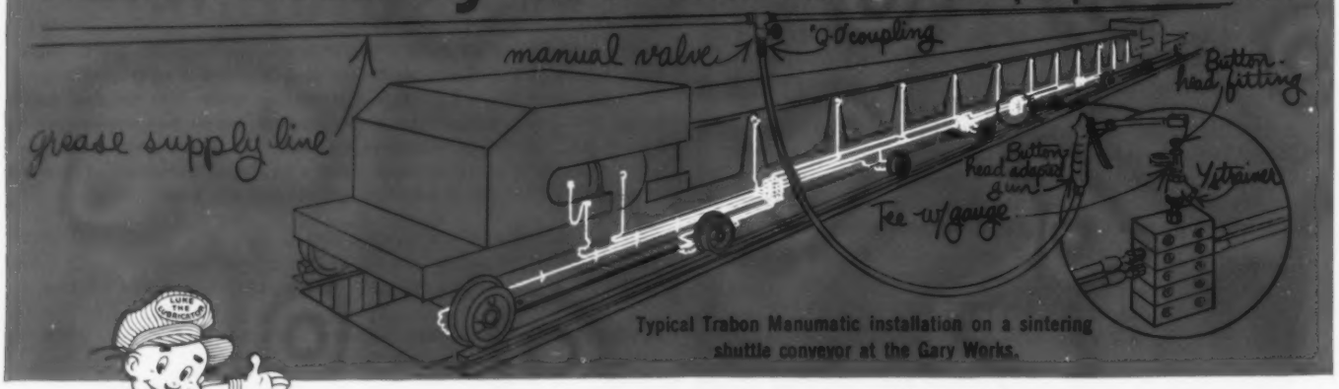
TRABON®

CENTRALIZED LUBRICATING SYSTEMS

Trabon Manumatic Systems were selected by U.S. Steel to provide the simplest, most positive means of lubricating a large number of bearings at their new Gary Sintering Plant. Nine automatic air-operated pumps supply grease under pressure to header lines, lubricating idler rolls, return idlers, take-ups, etc. To lubricate 50 or more bearings at any Manumatic station, the operator simply opens the valve for five or ten seconds. There are no hand pumps to work or fill—no tedious checking of individual valve indicators. And every Manumatic System has built-in central warning! Specify Trabon, the modern way to protect your machinery.

21,591 bearings at the new Gary Sintering plant...

lubricated by Trabon - and not a hand pump to fill or work



Typical Trabon Manumatic installation on a sintering shuttle conveyor at the Gary Works.

"Centralized" OIL AND GREASE SYSTEMS "Meterflo" CIRCULATING OIL SYSTEMS
"Meter-Mist" OIL SYSTEMS

Trabon® **Trabon Engineering Corporation** 28815 Aurora Road • Solon, Ohio

Equipment News...

WEIGHING UNIT

△ Whole I-beams—as long as 40 ft and weighing as much as 2500 lb—are being weighed immediately after rolling at a large eastern Pennsylvania steel mill.

The weighing is done on an electronic device, the first practical development for doing the job.

Prompt weighing has important advantages:

1. It permits accurate rolling to specifications.
2. It reduces waste.

SR-4 load cells, products of the Baldwin-Lima-Hamilton Corp.'s Electronics and Instrumentation Division, are the sensing elements of the weighing system.

Before the SR-4 electronic weighing system was installed, an entire beam could not be weighed. Instead, a sample draft, cut from a beam was weighed on a mechanical scale located in another building. Even if the draft showed the beam over or under weight, during the time required by this method several more beams could be rolled incorrectly.

If the cross section were too small, the beam might not meet the customers' specifications. If it were too large, steel was wasted.

In addition, the draft-weighing method did not show accurately whether the beam from which the draft was cut was over or under weight. The sample section might have been taken from a portion of the beam with a cross section larger or smaller than the average.

With the new electronic system, instructions can be flashed instantly to the roller, should his beams be outside of the two per cent tolerances allowed. Subsequent rollings can be adjusted to fall within prescribed tolerances.

With the electronic system, a beam is weighed at the front of the hot bed before it is moved to the rear for cooling. Between the hot-bed rails eight support rails project from a platform beneath the bed. This platform rests on four 2000-lb SR-4 load cells—one on each corner. Between the base of each load cell and the concrete piers that support the system is an elevating superstructure, which, by means of an electrical drive mechanism, can raise the weighing support rails above the level of the hot bed.

This arrangement protects the support rails and superstructure from possible damage. The system is out of reach below the hot bed except when it is weighing a beam.

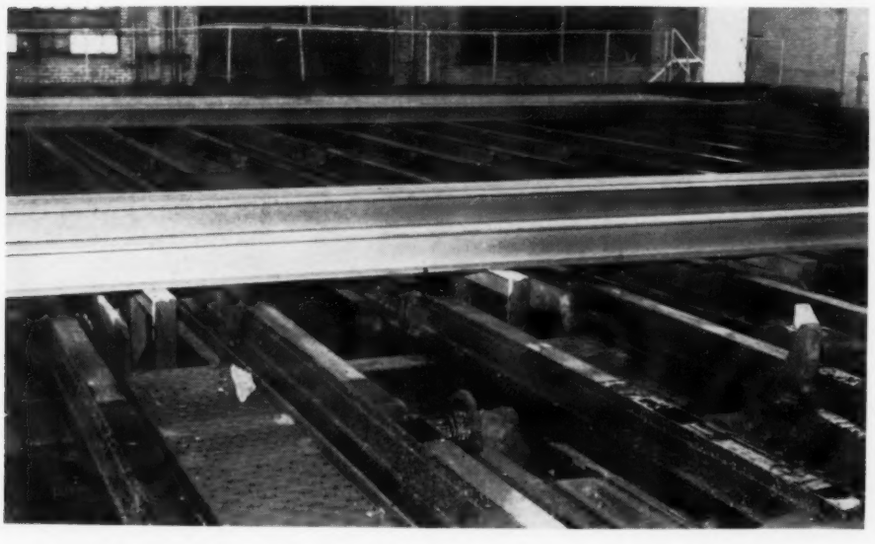
As the elevating structure raises a beam for weighing, an immediate reaction occurs in the SR-4 load cells. A change of resistance within the load cell—proportional to the weight of the beam—is transmitted as a change in voltage via an amplifier to serve and balance motors located in the dial mechanism of a console. The signal moves the pointer on the calibrated dial until the exact weight of the beam is indicated. The weight is simultaneously printed on a logging card, which the operator places in a slot beneath the dial. After the weighing, the elevating mechanism automatically lowers the beam to the hot bed.

The system is calibrated weekly. Fifty-pound weights are used to simulate a beam. In the near future a calibrated beam, suspended from the ceiling, will be lowered onto the scale for calibration. With this method the scale can be calibrated in a few minutes rather than the 20 to 30 minutes now required.

During the six months that the scale has operated, the only maintenance required has been routine inspection and lubrication of the elevating superstructure and drive mechanism. Aside from the drive mechanism, there are no moving parts to lubricate. Weighings are made at an average rate of one to two per hour throughout 20 eight-hour shifts per week. The electronic system has been in service around the clock with nodowntime recorded.

One reason for selecting the SR-4 equipment was the success of a previous installation in a shipping section of the plant. For some time there, SR-4 load cells have successfully weighed heavy rods, pipes and other steel products.

A 40-ft I-beam is weighed electronically on the hot bed. Short support rails, shown between hot bed rails, transmit weight of raised beam to SR-4 load cells beneath bed. After the beam is weighed, the support rails are lowered below the surface of the bed, protecting them from damage.



SCARFING TORCH

△ A new hand scarfing torch with a universal mixer that enables it to operate on either acetylene or fuel gas has been introduced by Linde Co., Division of Union Carbide Corp. Known as the Oxweld C-65 the scarfing torch is equipped with a

starting rod feeder that provides quicker starts and prevents the formation of "fins" by eliminating normal preheat time. Designed for removing surface defects from steel ingots, billets, blooms and slabs prior to final rolling, the new Oxweld C-65 torch is ideal for use on large-size seamless steel rounds.

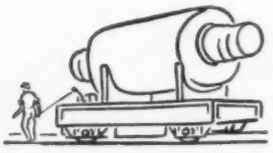
Nozzles used with the new torch are designed to produce a broader low velocity oxygen stream, increasing the width of the area that can be scarfed in a single pass of the torch. Specially designed nozzles used with the C-65 Torch are shorter ($4\frac{9}{16}$ in. long) than conventional nozzles increasing their rigidity and increasing nozzle service. Longer nozzles tend to bend in the extreme heat to which they are exposed. Rod feed is actuated by the cutting oxygen lever and is easily controlled by the operator. Feeders are adjustable to alter the length of stroke or to compensate for nozzle wear.

Flashback is prevented by the spring-loaded floating gas mixer which assures proper proportioning of gases. With this advanced universal mixer the C-65 can be used with either acetylene or fuel gas without changing mixers.

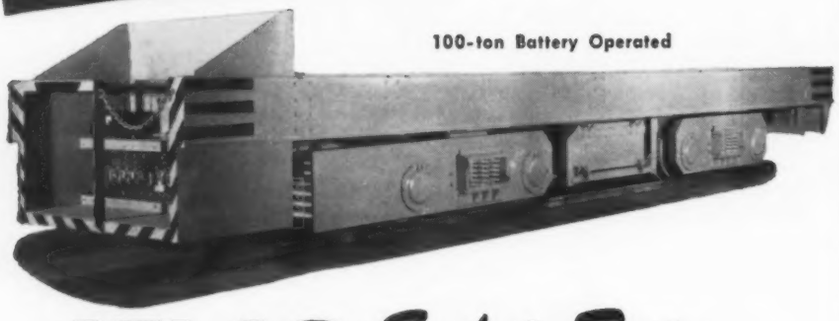
An automatic compensator valve minimizes the effect on the preheat flames when the cutting oxygen lever is depressed.

Available in three lengths—36 in., 42 in. and 48 in.—the new torch is ruggedly constructed to provide long, trouble-free operation. Precision cast one piece torch heads are easily replaced and are reinforced at wear points with a special Haynes Stellite alloy. Plastic needle-valve packings provide absolutely gas tight seals.

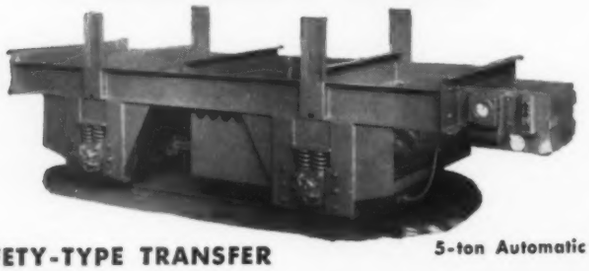
HANDLES THE BIG LOADS WITH BIG SAVINGS



100-ton Battery Operated



ATLAS *Safety Type* TRANSFERS



5-ton Automatic Controlled

ATLAS SAFETY-TYPE TRANSFER CARS can be provided in almost any capacity for storage battery, diesel or gas-electric, or cable reel service.

They are safe because there is only one control lever, and the car moves only when the operator holds the lever.

Request "Walk-Along" Bulletin 1283.

ATLAS CAR & MFG. CO.
1100 IVANHOE ROAD
CLEVELAND 10, OHIO

ENGINEERS AND MANUFACTURERS SINCE 1896

DRAWBENCH

△ A new 10,000 lb drawbench is announced by Lombard Corp. Reported to be a radically different concept in drawbenches—it is designed primarily for plug and bar drawing of seamless and welded stainless and alloy steel tubing $\frac{1}{4}$ in. to $\frac{1}{2}$ in. in diameter—but can be used for drawing other standard or special metals or to meet unusual operating conditions.

The drawbench is said to fill a great need for economical, very versatile machines now lacking in the industry. A hydraulic cylinder drive provides maximum operating flexibility at minimum cost and permits easy adjustment of draw and return speeds through a range of 0 to 75 fpm. It eliminates pulsations which are inherent in chain-type drawbenches. The operation may be stalled at any point along the draw length to inspect the product or change draw conditions.

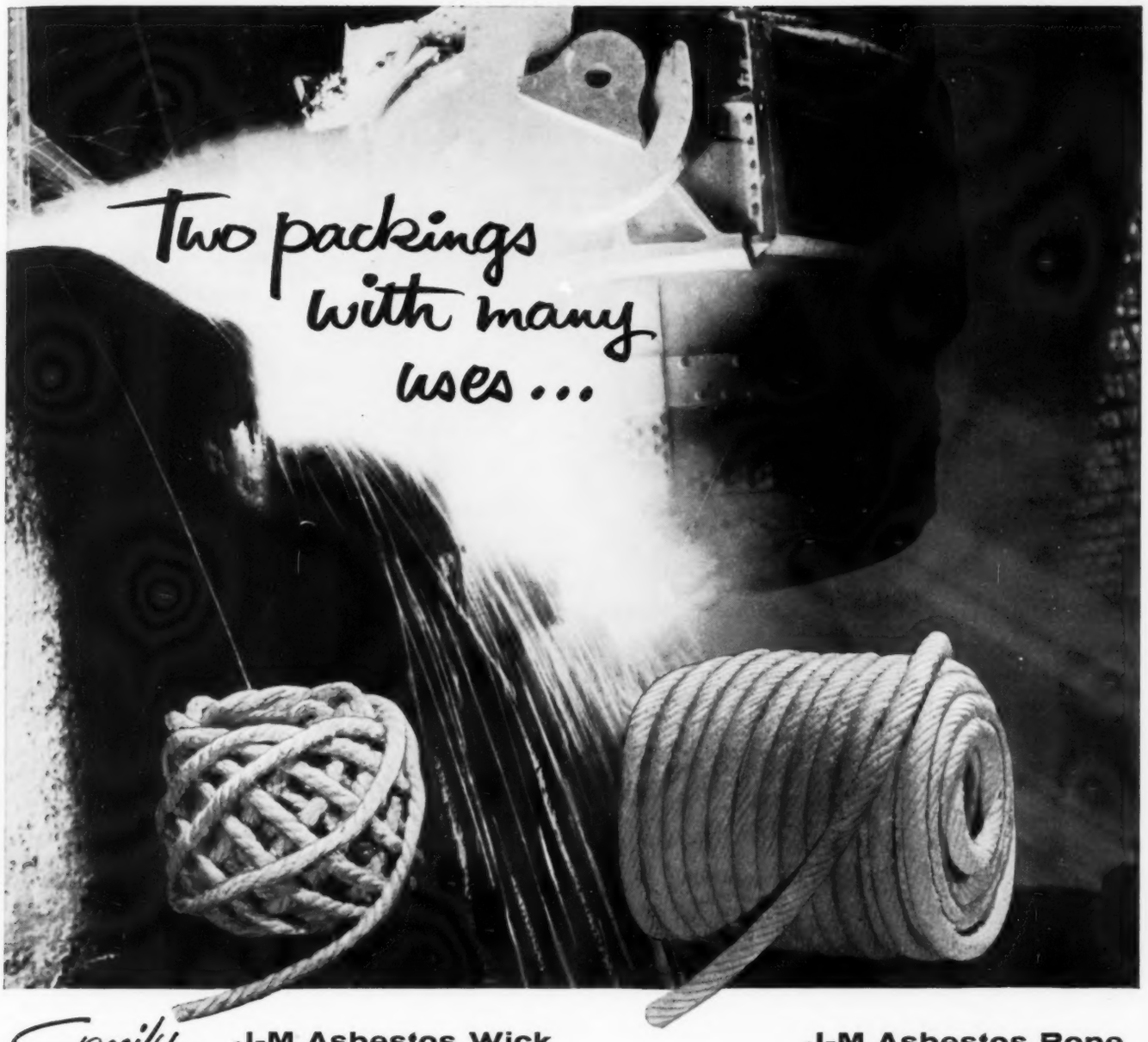
RELAY

△ A direct monitoring overtemperature relay device for use in a wide range of a-c applications has been developed by Cutler-Hammer Inc.

The product consists of a magnetic relay, two transistor amplifiers, a diode network for signal separation and a voltage regulated power supply.

Though specifically designed to protect 3-phase a-c motors, the unique features of this relay make it suitable for use wherever overtemperature is a problem.

Chief advantage of the new design is that it permits maximum



Specify... **J-M Asbestos Wick** **J-M Asbestos Rope**

Wherever you need general utility packings that are easy to handle, highly heat resistant

Throughout the iron and steel industries, the list of uses for Johns-Manville Asbestos Wick and Rope is constantly growing. These soft, resilient, heat-resisting materials are widely employed for general packing, gasketing and caulking applications.

In coke ovens, both are used to caulk around the doors to prevent the escape of gases. Asbestos Rope (Style 4200) also serves as expansion joint material in the brickwork.

Only a few of the many applications for Asbestos Wick (Style 4202) can be given here. It seals hot metal in the ingot mould, around the top and between the mould and the stool. It gives protection from burning to water hoses that cool Open Hearth doors. It serves as a seal between the cope and drag on moulding flasks. It is used to wipe excess coating from wires after passing through the galvanizing bath.

Styles 4200 and 4202 are made from pure asbestos fibre carefully controlled for quality at Johns-Manville's own mine and mill (largest in the world). Asbestos Rope is formed by twisting together two or more strands of Wick to obtain the desired thickness. For further information, call your local J-M distributor or write Johns-Manville, Box 14, New York 16, N. Y. In Canada, Port Credit, Ontario.

Johns-Manville PACKINGS, GASKETS and TEXTILES

JOHNS MANVILLE JM PRODUCTS

use of equipment without danger of overheating because the component responds only to the actual temperature of the protected equipment. This, of course, is due to the fact that the thermistor is inserted in the windings of the motor, generator or transformer.

Power supply ratings are 110, 208/220, 440 or 550 volts, 60 cycles. Contacts are the pilot duty type, 600 volts a-c maximum.

POWER CABLE

△ A new 28-kv power cable with 33/64-in. thick butyl-rubber insulation has been developed by the National Electric Division, H. K. Porter Co., Inc.

The heavier insulated cable is expected to have wide application in the electric utility field, particularly in generating stations and distribution substations. It is most commonly used as primary lead cables for generators, transformers

and other distribution equipment. The increasingly higher voltages used in modern transmission systems has created a need for cable with substantially thicker insulation to sustain the increased physical and electrical demands placed upon it.

The cable—in addition to its heavy 33/64-in. insulation—has a 7/64-in. neoprene outer jacket. It has an outside diameter of 2.3 in. and weighs 3.6 lb per foot.

The new cable has been tested at 120-kv a-c for five minutes and 150-kv d-c for 15 minutes without any evident physical or electrical deterioration.

SINTER COOLER

△ Expanded and modernized sintering facilities at one of the plants of a large East Coast steel firm will be served by a circular air cooler that will cool up to 4000 tons of hot sinter a day.

Red
CIRCLE ROLLS
for every purpose

Uniform performance, high production and long service are unfailing characteristics of these better rolls.

Preferred by leading mills throughout the nation for more than half a century.

Yes, there's a Red Circle Roll for every purpose.

ROLLS

Nickel Alloy Grain Rolls
Grain Rolls
Chilled Rolls
Nickel Chilled Rolls
Moly Rolls
Nodular Iron Rolls

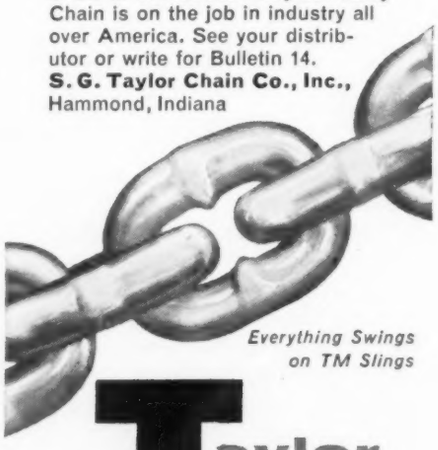
All Grades Nickel Alloy Iron Rolls for Hot and Cold Rolling

Hyde Park
FOUNDRY and MACHINE CO.
HYDE PARK
Westmoreland County, Pa.

Rolls
Rolling Mill Equipment
Gray Iron Castings

TOPS *in*
SAFETY

TM Alloy Chain puts muscle in your safety record. Enormous tensile strength—125,000 lbs. p.s.i. . . . rugged stress-free links . . . controlled heat-treating. These are a few of the reasons why TM Alloy Chain is on the job in industry all over America. See your distributor or write for Bulletin 14.
S. G. Taylor Chain Co., Inc.,
Hammond, Indiana



Everything Swings on TM Slings

Taylor Made CHAIN SINCE 1873

A New Era
in
Relay Life and Reliability

NEW
Bulletin 700, Type B-220A, AC Control Relay with 2 N.O. and 2 N.C. contacts.

NEW
Bulletin 700, Type BX-440A, AC Control Relay can be wired for normally open or normally closed contacts.

NEW ALLEN-BRADLEY BULLETIN 700 RELAYS

Improved features set new performance standards

For years, Allen-Bradley Bulletin 700 Type B and Type BX relays have been preferred for their long life and trouble free operation. The improvements in the new Bulletin 700 Type B and Type BX relays will set new performance standards wherever they are used. Naturally they use the famous A-B double break, silver alloy contacts which always remain in perfect operating condition without cleaning or filing. The cast coil cannot be damaged by the severest atmospheric conditions.

These new Allen-Bradley Bulletin 700 Type B and Type BX relays offer even greater value and greater reliability than ever before—but the price has not been changed.

- **New mechanical design gives at least 5 times greater operating life.**
- **New contact motion provides 10 times greater electrical reliability.**
- **Complete interchangeability—mounting dimensions are unchanged.**
- **New hermetically sealed plastic coil fits Bulletin 700 relays presently in use.**
- **New, stronger, movable contact crossbar—also fits old relays.**
- **New reinforced stationary contact blocks—interchangeable with previous design.**

Allen-Bradley Co., 1343 S. First St., Milwaukee 4, Wis.
In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

ALLEN-BRADLEY Quality Motor Control
Member of NEMA

Designed by Dravo Corp., under a licensing agreement with Lurgi Co. of Frankfurt, Germany, the cooler will be the first of its type built for an existing sinter plant.

The cooler will utilize 490,000 cu ft of air or almost 18 tons per minute to lower the temperature of hot self-fluxing sinter to a level that will permit its transportation on rubber conveyor belts to storage areas or blast furnace transfer cars. In the process the sinter will be cooled from approximately 1300 F to 200 F in about 30 minutes.

Conversion to self-fluxing sinter from ordinary sinter makes air cooling especially desirable in order to prevent excessive breakdown in sinter size.

Three 166,000 cfm fans will draw air up through the hot sinter as it moves around the 65-ft diam cooler on 8-ft by 5½ ft trays. Total cooling area will be 1300 sq ft. Air then will be carried off through a 15-ft diam central stack 85 ft high.

Dravo also will supply extensive auxiliary equipment for the cooler. Two sinter breakers, which will be installed on the sinter machines, will break up fused sinter material as it leaves the strands. From the breakers material will pass onto an apron feeder and from there onto a vibrating screen which will remove hot fines—small particles and dust. A vibrating conveyor will "flow" the chunks of sinter into the cooler.

A TKV pan-type feeder will receive hot fines and all dust gathered from an existing dust collecting system and an additional system which Dravo will install. This material will be discharged into a 115-ton hopper, from which it will be fed by a vibro-feeder into an existing pugmill for refeeding to the sinter machines.

Sinter leaving the cooler will be delivered by a vibrating feeder onto one of two loading out conveyor belts for either storage or blast furnace charging.

COMPRESSORS

△ A new line of centrifugal compressors has been developed by Elliott Co. to meet a long-standing need in low-flow, high-pressure ratio applications.

Available in both single- and two-stage designs, they feature simplicity, flexibility in materials of construction and adaptability to handling gases other than air.

Important advantages are freedom from vibration of flow pulsations, light weight and small space, and the ability to provide oil-free air. Only a simple, inexpensive foundation is needed. Capacities range from 800 to 8000 cfm, pressure to 1000 psia.

The Type R compressor line introduces a new design concept.

(*Please turn to page 233*)

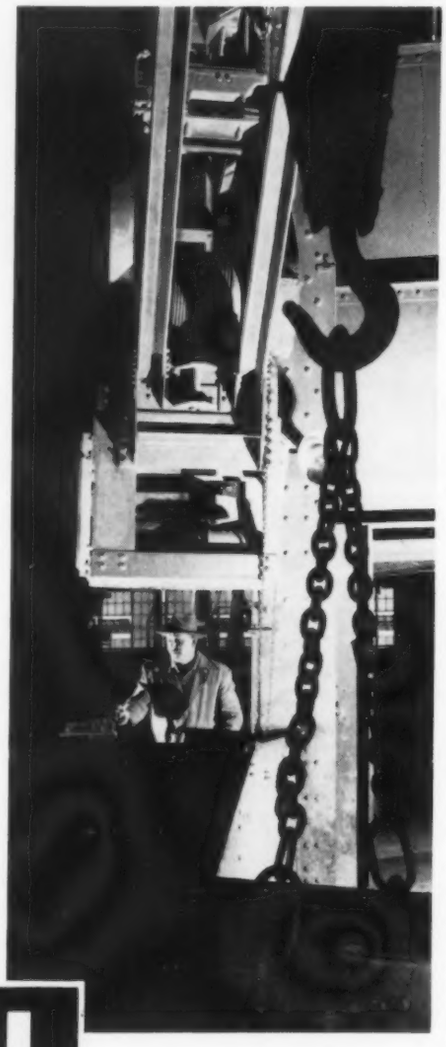
TITZEL CRANES
contribute to Production Efficiency

in Steel Plants, Aluminum Plants and other Allied Industries

Every Titzel Crane installed is individually engineered and precision built for its specific application. Titzel Cranes provide smooth, safe, dependable operation and give consistently efficient, long-lasting performance. For complete information write or phone MUseum 1-9622.

FROM DESIGN TO INSTALLATION

- Jib and Casting Pit Cranes
- Hot Topping and Capping Cranes
- Jib, Pillar, Wall and Floor Traveling Cranes
- Cover Cranes for Steel and Aluminum Plants
- Button and Skull Burning Cranes for Scrap Yards
- Stopper Rod Drying Ovens
- Hydraulic Descaling Systems
- Mill Scale Handling Systems
- Palm Oil Systems
- Mill Dust Handling Systems
- Pneumatic and Mechanical Conveyors
- Designers and Manufacturers of Special Equipment



Since 1928 **TITZEL ENGINEERING, INC.**

260 42ND STREET, PITTSBURGH 1, PA.

ALLIED COMPANY, TITZEL ENGINEERING & EQUIPMENT CO.

Giant generator gets new coils by National

...*The* Specialists in electric coils/repair service

When one of Bonneville Dam's big waterwheel generators required rewinding, National's experience in coil design and production was put to work.

National built a complete set of stator windings, comprising 594 coils, plus circuit rings and connection taps and furnished complete winding supplies. All coils were given high frequency tests at 10,000 volts, to check turn-to-turn insulation, and 40,000 volt ground test A.C. 60 cycle for one minute.

National also furnished supervision for installation. Despite limitations in working space—the rotor was not removed from the machine but was jacked up sufficiently to permit winders to enter—the work was completed on schedule. Generator No. 10 is now back in service—and is running several degrees cooler than before rewinding.

Put National's broad experience to work on *your* winding needs.

For more information call National's Columbus plant... HUdson 8-1151. Or call the nearest National field engineer.

National Electric Coil

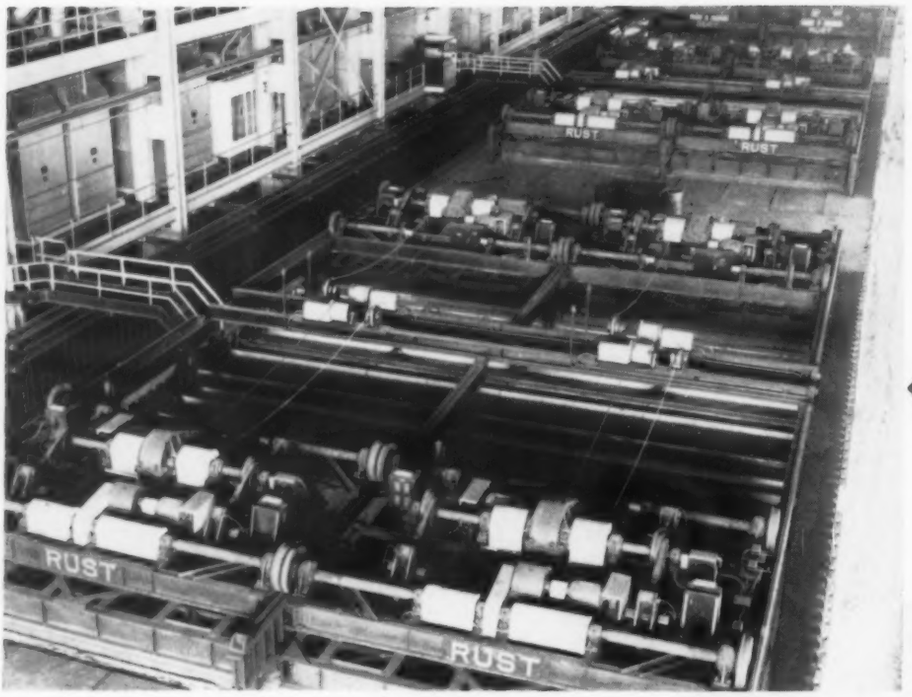
DIVISION OF McGRAW-EDISON COMPANY

COLUMBUS 16, OHIO

McGRAW EDISON

ELECTRICAL ENGINEERS • MANUFACTURERS OF ELECTRICAL COILS, INSULATION, LIFTING MAGNETS • REDESIGNING AND REPAIRING OF ROTATING ELECTRICAL MACHINES

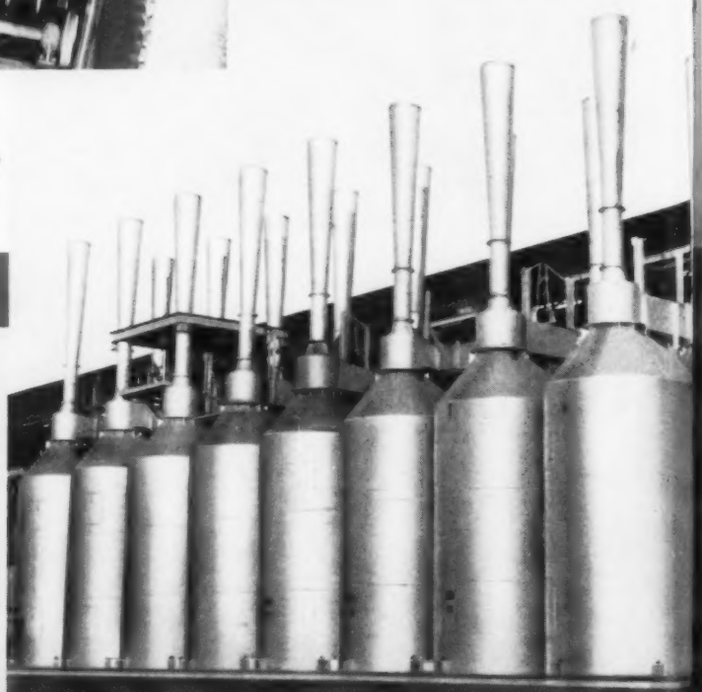
For Peak Soaking

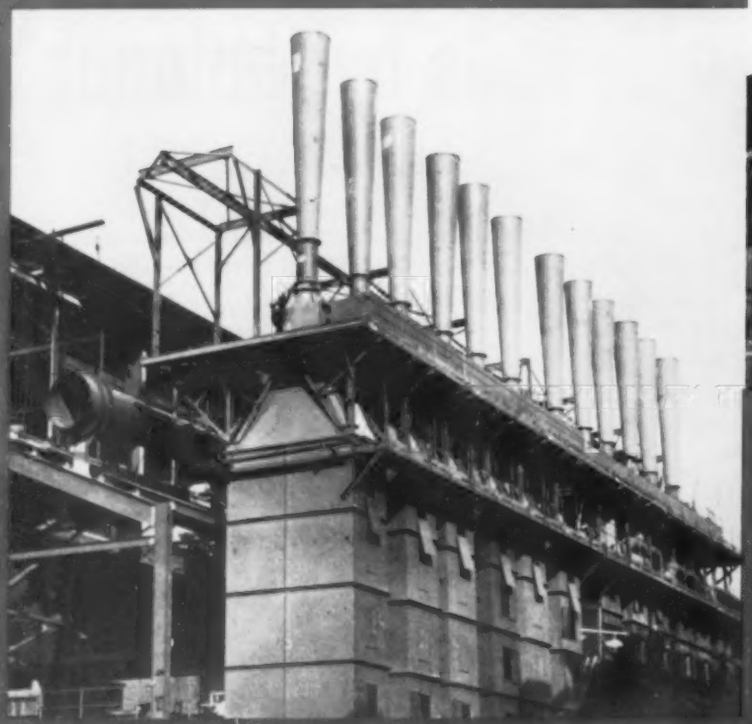


A leading mid-west Steel Mill selected Morgan-Isley Systems for their improvement program on 20 holes of regenerative soaking pits.

Morgan-Isley System with secondary regenerators enabled large Eastern Steel Plant to use 106 Btu per cubic foot mixed blast furnace and coke gas in 16 hole cross fired soaking pits.

Installation at Keystone Steel and Wire where Morgan-Isley installations proved so effective that the mill quadrupled its soaking pit holes. Fuel either natural gas or bunker "C" oil.





Morgan-Isley Systems with secondary regenerators on 51 holes of soaking pits using straight blast furnace gas as fuel.

MORGAN
WORCESTER

Pit Performance...

The Morgan-Isley System of Combustion Control offers the modern regenerative soaking pit the most effective means of heating ingots for primary rolling.

Simple, completely modern temperature and combustion controls with automatic reversal insure rapid, efficient heating with excellent uniformity from top to bottom of ingots.

With the Morgan-Isley System you can utilize fuels ranging from straight blast furnace gas, various mixtures of blast furnace and coke oven gas, straight coke oven gas and up to and including natural gas or bunker "C" oil.

Modernize your soaking pits with Morgan-Isley—consult us about your requirements.

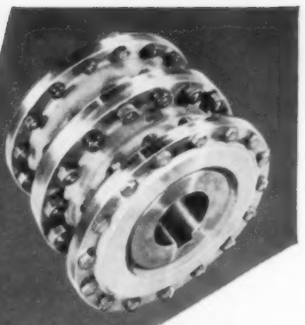
CCC-61

MORGAN CONSTRUCTION COMPANY WORCESTER, MASSACHUSETTS

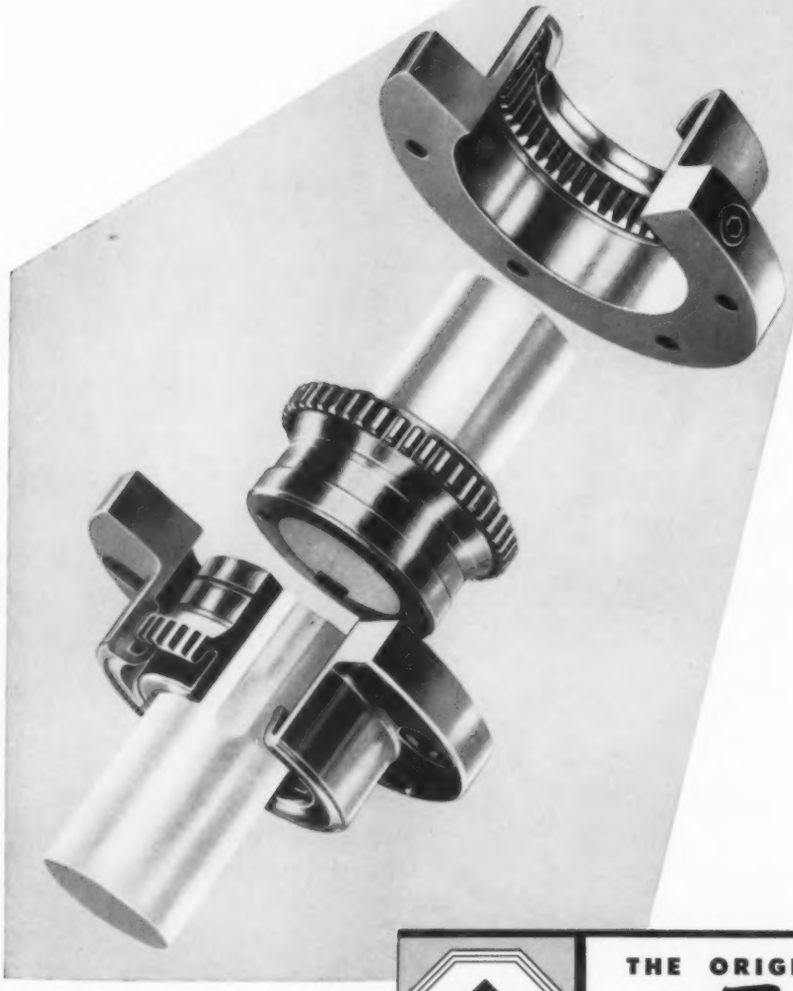
ROLLING MILLS • MORGOIL BEARINGS • WIRE DRAWING MACHINES • COMBUSTION CONTROLS

CCC-61

the basic coupling principle that couldn't be improved . . .



This principle makes every Fast's coupling . . . large or small . . . out-perform all others



The principle embodied in Koppers gear-type, self-aligning Fast's couplings couldn't be improved by anyone. Throughout industry, Fast's couplings are accepted as the most dependable couplings on the market. Experience has proved that they frequently *outlast the equipment* they connect.

Fast's couplings are sufficiently comprehensive in types, sizes and versatility to meet almost every known need for couplings. Available in forged steel for shaft sizes from ¾" to 6⅜" and in cast steel for shaft sizes from 5½" to 32".

Nearly 40 years of coupling experience guarantees that Koppers can supply the right coupling engineered for a given application. For the booklet describing Fast's couplings applicable to your equipment, write today to: KOPPERS COMPANY, INC., Fast's Coupling Department, 5010 Scott Street, Baltimore 3, Maryland.

KOPPERS

THE ORIGINAL

FAST'S Couplings

Engineered Products Sold with ***Service***

(*Continued from page 228*)

The cast casing and forged impeller element can be made of materials selected to meet application needs. Special bearing housings and seal designs permit lubrication with water or other lubricants, and obviate explosion hazards caused by oil contamination or toxic gas leakage.

An oxygen compressor, a modification of the Type R machine using stainless steel construction and water-lubricated bearings, is now in service.

VOLTAGE DRIVE

△ Using static power magnetic amplifiers, Square D Co. has developed a new adjustable voltage drive which provides extremely high reliability coupled with quiet operation. Magnetic amplifiers and semiconductors are used for the control and rectification of input power, and all components operate well within their ratings to assure a minimum of maintenance. Fail-safe circuits are used throughout for maximum protection of personnel and machinery.

The drive is particularly well suited for applications where warm-

up time or vibration cannot be permitted, and where a reputation of maintenance and downtime is important. Moreover, the new static power drive saves up to 51 per cent floor space and is up to 43 per cent lighter than equivalent motor-generator type drives.

The drives are available as standard packages in sizes ranging from ½ hp to 200 hp, and feature an 8/1 speed range with 5 per cent regulation. Standard modifications include dynamic braking, reversing, jogging and dynamic slowdown. Special modifications are also available for such applications as machine tools, conveyors and other types of continuous process lines.

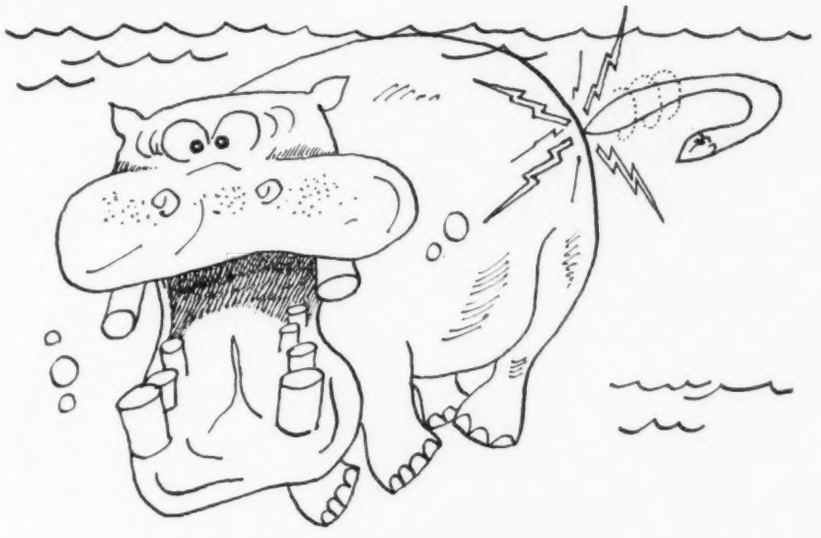
All drives are set up, tested and adjusted at the factory, leaving only an occasional trimming adjustment at installation time. Installation is further simplified by the complete instruction manuals provided with each drive.

INDUCTION MOTORS

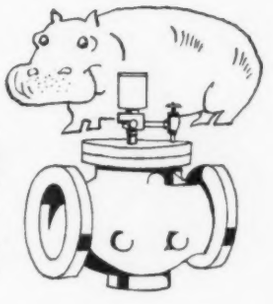
△ The Louis Allis Co. has announced the availability of a new line of large a-c induction motors in open drip-proof enclosures in ratings from 150 to 2000 hp at 1800 and 3600 rpm.

To meet special application demands, several bearing constructions are offered for the motors.

OPENS ON ELECTRICAL IMPULSE



G-A *Cushioned*
Solenoid Operated Valve



Where remote control valve operation is desired, specify and use the G-A Cushioned Solenoid Operated Valve that automatically opens or closes on any type of electrical impulse. The operating sequence—whether on open or closed circuit—can be made to suit your requirements. Sizes 2″ to 36″.

Bulletin W-7A has the complete story.

GOLDEN ANDERSON *Valve Specialty Company*

1220 RIDGE AVENUE, PITTSBURGH 33, PA.

Designers and Manufacturers of VALVES FOR AUTOMATION

Put your **HEAVY LOADS** *on* **WHEELS**!

...with EASTON heavy duty industrial cars and trailers designed and built with the know-how developed through 45 years of service to all areas of heavy industry.

WRITE FOR NEW CATALOGS

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EASTON CAR & CONSTRUCTION COMPANY
EASTON, PA.

▲ 100-ton walking-action trailer

EASTON ▶ turntable and power driven transfer car

CUSTOM BUILT

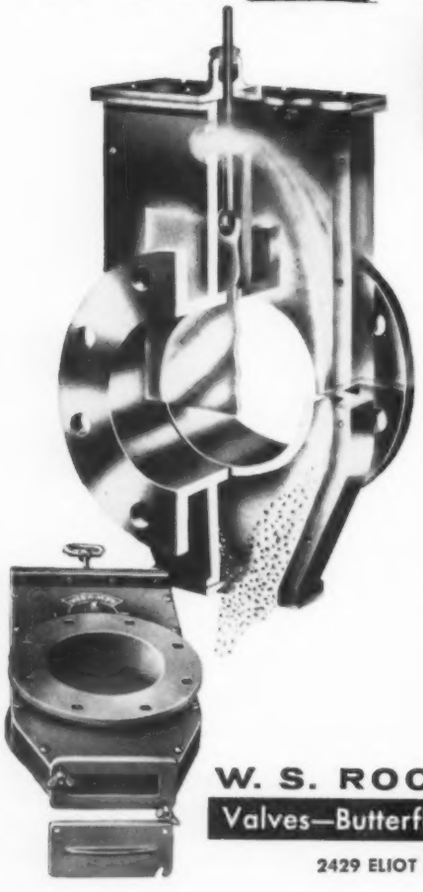
® REGISTERED TRADEMARK OF EASTON CAR & CONSTRUCTION COMPANY

A-1065

You need never remove

KWIKLEEN

SLIDE VALVES from the lines for cleaning



For fluids, air or gases containing solids or for free flowing granular materials that clog or jam conventional valves—Kwikleen is the answer.

It permits 100 per cent flow in full open position and quick shut-off manually or mechanically. Easily, quickly cleaned by removing bottom plates. The valve need not be removed from the line. Sediment drops out or can be blown or flushed out by air or water.

Ask for Bulletin 501.

W. S. ROCKWELL COMPANY

Valves—Butterfly · Slide · Diaphragm · Special

2429 ELIOT STREET • FAIRFIELD, CONN.

Inspection and maintenance of the motors' capsule types, sleeve bearing and oil rings are easily accomplished by removing the top half of a split bearings bracket and split bearing capsule. Of special note is the use of bronze inserts in the bearing capsule to achieve close tolerance running fits between capsule and shaft.

Anti-friction bearings are utilized in slow speed motors, 1200 rpm and

below, and for direct-coupled drives. For v-belt, gear or chain and sprocket drives, ball or roller bearings are supplied depending on the speed, hp and overhung load on the output shaft. Three-bearing motors with outboard pedestal type bearings are also available.

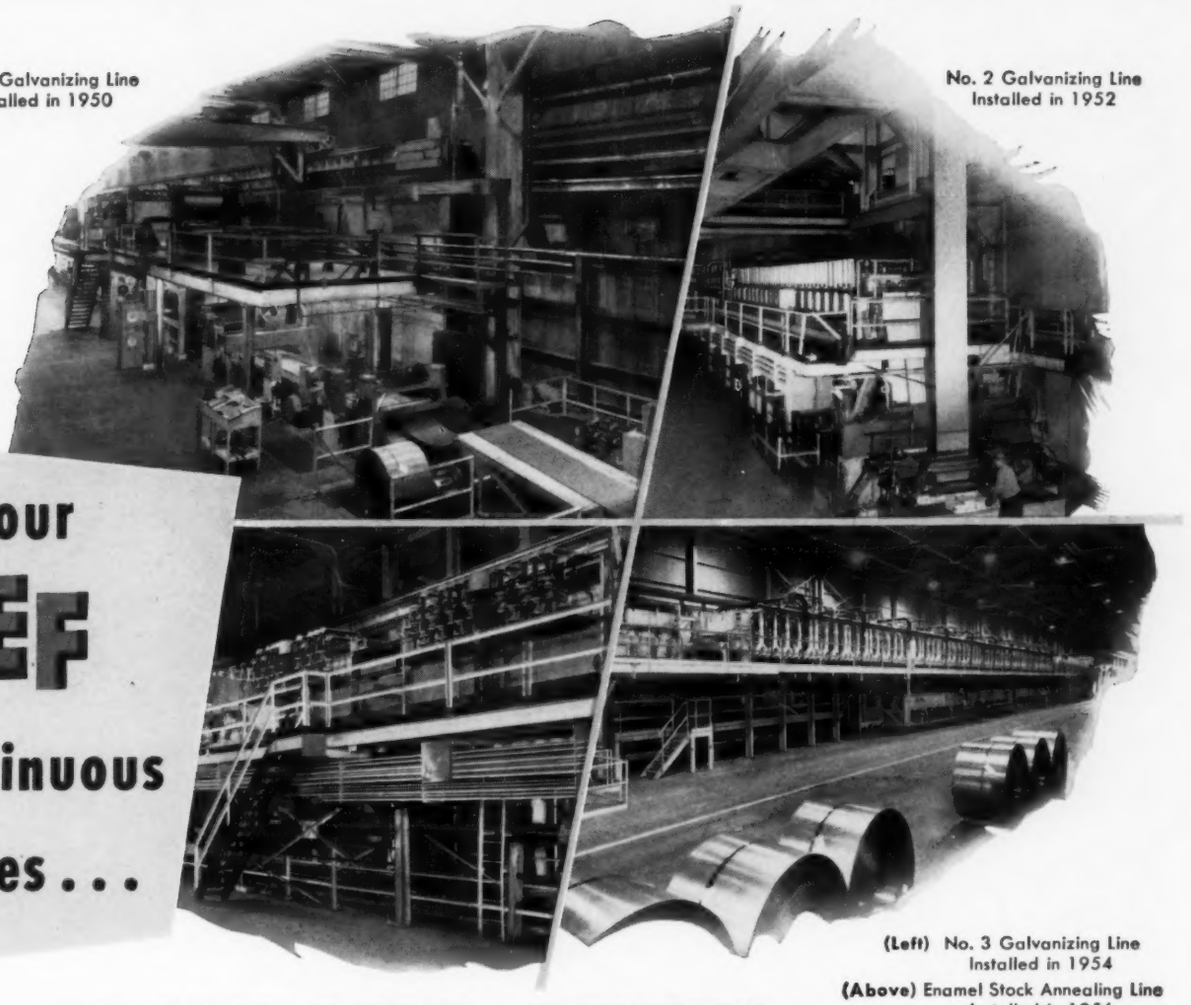
A pressure lubrication system is standard with large a-c induction motors for 3600 rpm, 1000 hp ratings and larger, and is optional with smaller, slower speed motors. A separate-motor pressure lubrication system insures oil pressure build-up before starting and insures maintained oil pressure during coastdown.

Internally, the motor windings are protected by an insulation system. Special design emphasis was placed on the ventilation system to achieve minimum motor noise levels.

JET COOLING UNIT

△ Jet cooling, a major innovation in annealing furnace design, developed by the General Electric Co.'s Industrial Heating Department, now permits increased furnace output, and as much as 30 per cent reduction in floor space required by the annealing section of a typical continuous cleaning and annealing line.

This design for faster cooling of light-gage strip employs a number of self-contained, independent units, each with its own 60-cycle, motor-



No. 1 Galvanizing Line
Installed in 1950

No. 2 Galvanizing Line
Installed in 1952

Four EF Continuous Lines . . . at INLAND STEEL

(Left) No. 3 Galvanizing Line
Installed in 1954

(Above) Enamel Stock Annealing Line
Installed in 1956

provide efficient 24 hours a day, 7 days a week operation at high efficiency, with no unscheduled downtime.

TOTAL DESIGN CAPACITY IN EXCESS OF 617,000 TONS PER YEAR*

Repeat orders are the highest endorsement a furnace builder can earn. Tailored to meet Inland's specific requirements, and incorporating the most advanced technological improvements, these four EF continuous lines assure accurately controlled cycling, maximum production and maximum return per dollar invested.

The unvarying day after day uniformity of product physicals, assure highest market acceptance, and make subsequent forming and fabricating operations more efficient and less costly.

For up to the minute engineering, outstanding performance, and greatest return on your investment, on any continuous — or batch — ferrous or non-ferrous heat treating project, you'll find, like Inland, that "it pays to call the EF furnace engineers".

*Tonnage output will vary depending upon width and gauge of strip being processed.

EF

THE ELECTRIC FURNACE CO.

Gas-fired, Oil-fired and Electric Furnaces for Heat Treating any Product, Using any Process, any Hourly Output.

300 West Wilson Street *Salem - Ohio*

Branch Offices in Detroit, Mich., Santa Ana, Calif., and Cheshire, Conn. Canadian Associates, Canefco Limited, Toronto 13, Ontario

driven blower and heat exchanger. These units force high-velocity cooled gases against, and perpendicular to, each strip surface.

Each of the jet units is readily accessible, providing for simple maintenance and for flexibility of operation. When furnace is designed for additional capacity in the future, cooling facilities may be extended easily by the installation of additional jet units and rolls.

The commercial feasibility and operating performance of the new system is being demonstrated by a General Electric tower-type, jet-cooled annealing furnace installed at the Wheeling Steel Corp. plant in Yorkville, Ohio.

According to Mr. A. B. Chamberlin, annealing superintendent at Yorkville Works, the new furnace has shortened the over-all length of the cleaning and annealing line by about 10 per cent.

According to General Electric engineers, the primary feature in furnace design is the marked increase in heat transfer now possible. This increase permits cooling to temperatures lower than any other known dry cooling methods.

Jet cooling is effective in the temperature range of 900 F to 100 F for furnaces operating with strip speeds up to 2000 fpm at outputs up to 60 tons per hour. Eight passes of strip in the cooling portion of a new tower-type annealing furnace can now accomplish the cooling that 30 passes produce with conventional "cool room" or water-wall designs.

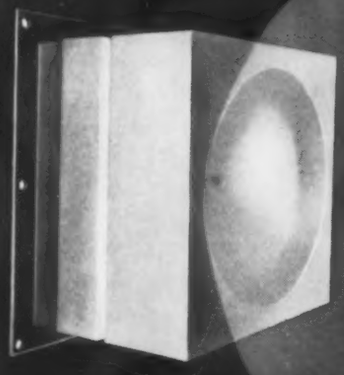
A-C MOTORS

△ Announced by Reliance Electric and Engineering Co. is a new line of integral horsepower a-c motors.

Now available in sizes from one through 250 hp in protected (open), weatherproof, totally-enclosed, corrosion-proof and explosion-proof enclosures, the "Duty Master" motors may be specified in all standard speeds and voltages. Designs include polyphase, ball bearing, vertical and horizontal mounting arrangements with feet or footless, with NEMA C-face, D-flange or P-base brackets.

New single-phase motors, sleeve bearing motors, resilient mount motors and larger rerated sizes in the Duty Master design will be introduced in the coming months.

PLENTY OF INTENSE HEAT
BUT NO FLAME IMPINGEMENT



HAUCK
High-Radiant
Cone
Gas Burners
for
HIGH THERMAL
RELEASE

and fast, precise heating

Write for Data Sheet No. GB 809LB

Gas Burners • Oil Burners
Combination Gas and Oil Burners
Blowers • Pumps • Oil Heaters

HAUCK MANUFACTURING CO.
COMBUSTION ENGINEERS

114-124 TENTH STREET • BROOKLYN 15, N. Y.

READY TO SHOOT

Large clevis is positioned for x-ray shots at Elyria, Ohio, plant of Electro-Alloys Division, American Brake Shoe Co. This clevis is used to lower, support, and raise 70,000 lb forgings in heat treating furnaces operating at temperatures up to 1850 F.

"Our new facilities for steel roll production have certainly paid off for National Roll users,"

says Bill Curran, Works Manager

"There's been a lot of comment in the industry about the big things that have been going on for the past few years at National Roll . . . expansion and new equipment that are reflected in better steel rolls for our customers.

"For example, we have in operation a new foundry, complete with modern equipment, including additional furnace facilities. This foundry is used exclusively for casting steel rolls—rolls produced by the latest methods and newest equipment to give you longer tonnage life.

"We've also added new equipment for pouring, annealing and machining rolls—both iron and steel—in a wide range of sizes.

"And while we're telling you about all the 'NEW' let us remind you that National is 'OLD' in the business of producing fine rolls. With this combination of the 'OLD' and the 'NEW,' we know we can produce rolls to your satisfaction."

GENERAL STEEL CASTINGS

National Roll & Foundry Division

Avonmore (Westmoreland County) Pennsylvania

General Steel Castings Corporation: General Offices, Granite City, Ill.

Plants: Granite City, Ill.—Eddystone, Pa.—Avonmore, Pa.

One of the principal features of the new motors is the low inertia, fast accelerating rotor. Constructed of pressure-cast aluminum, the rotor is dynamically balanced to movement tolerances as precise as 0.0002 of an inch, to prolong bearing life and produce quiet operation. The low inertia rotor and increased accelerating torque combine with improved double-end ventilation to provide frequent stops and starts without risk of injurious overheating.

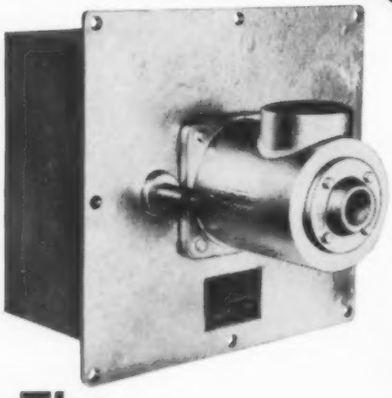
The rugged cast-iron frame of the new open motors protects from dripping or splashing liquids, and has a 40 C temperature rise, continuous duty, with a 15 per cent service factor. The frame can be easily adapted to splash-proof requirements when wall-mounted. The new motors feature double-end ventilation on horizontal units above the 180 frame size, and through ventilation on all vertical or flange-mounted horizontal models through the NEMA 445U frame.

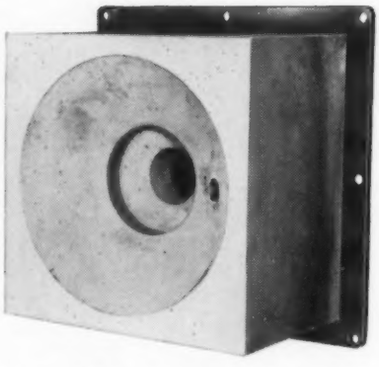
Lubrication consists of double-shielded ball bearings and a special metering plate which automatically regulates the flow of just the right amount of grease to the bearings as needed. Automatic grease relief along the shaft eliminates overgreasing, while a special tight steel grease retainer on the inside of the bearings keeps dirt from entering the bearings and prevents grease from passing into the motor interior.

Slot cell insulation is laminated mylar-paper; the phase insulation is varnish glass, which is impervious to contaminating atmospheres. Molded, plasticized top and mid sticks and vinyl glass sleeving on the leads complete the balanced insulation system. Preheated dry windings are repeatedly immersed in thermosetting varnish and baked, then coated with a special red finishing enamel for complete protection against acid, alkali, water, oil and most adverse environmental contaminants. Coil heads are designed to tuck snugly within the protective cover of the motor frame, to prevent damage during assembly or disassembly.

The large conduit box is diagonally split to expose the leads for convenient connection. Positive, permanent lead markings of each wire provide instant identification of leads to minimize connection time. The stainless steel nameplate provides room for additional customer data, if required. It can't corrode, and comes clean with the wipe of a rag even after long exposure to corrosive atmospheres.

Focus High Heat





The BLOOM HTR BURNER

The Bloom High Thermal Release Burner can be located in a furnace roof or wall to give the operator the temperature he needs for a given area. Maintenance on this burner is minimized, since alloy or cast iron parts aren't exposed to high temperature.

Applications include:

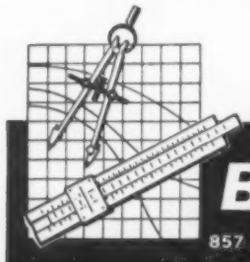
Tube Upsetting

Continuous Strip Pre-Heating, Annealing, Coating, and Drying

Batch type Forging

Aluminum Chip Melting

Meta-Silicate Melting



BLOOM ENGINEERING COMPANY, INC.

857 WEST NORTH AVENUE • PITTSBURGH 33, PENNSYLVANIA

ENGINEERING • EQUIPMENT • SERVICE

FIREBRICK

△ A stronger and improved insulating firebrick that is light in weight and low in thermal conductivity has been placed on the market by the Refractories Division of The Babcock & Wilcox Co.

Known as B&W K-20 and K-23, the insulating firebrick was engineered to meet the rugged requirements of furnace builders and operators in the metals, structural clay, petroleum, chemical and glass industries.

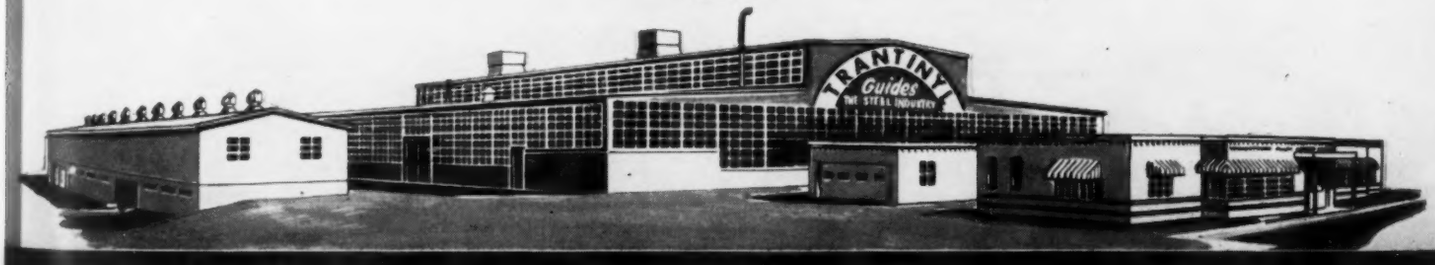
The mechanical strength of the refractory has been increased by more than 65 per cent for the B&W K-20 and by more than 50 per cent for the B&W K-23. This increase, officials claim, will enable the insulating firebrick to be used in a wider range of applications. They added that it can be fitted with hangers or pins without danger of breakage.

The K-20 has an average weight of 1.70 lb per 9-in. straight, while

(*Please turn to page 250*)

TRANTINYL

guides the steel industry



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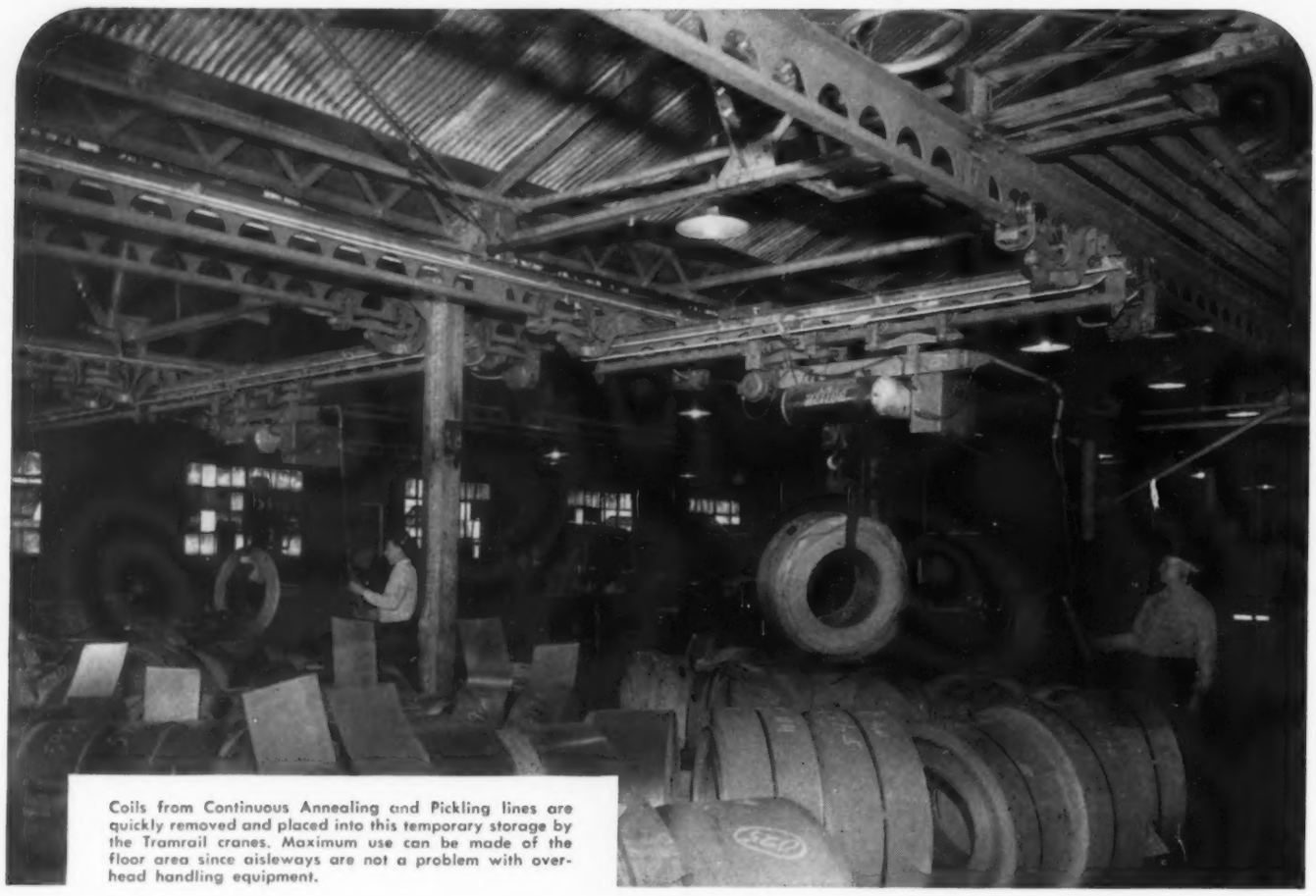
ROLLING MILLS: bar, hoop, strip, shape mill guides, and rollers. SEAMLESS TUBE MILLS: guide shoes, rolling mill plugs and rolls, piercer points, etc.
ELECTRIC WELD TUBE MILL: forming rolls, planishing rolls, tool holders, etc. • STRAIGHTENING MACHINE GUIDES • HEAT RESISTING CASTINGS

Tramrail Cranes BOOST Strip Production

Speed Handling—Cut "Down Time"—Aid Safety



Coils from Continuous Annealing and Pickling lines are quickly removed and placed into this temporary storage by the Tramrail cranes. Maximum use can be made of the floor area since aisleways are not a problem with overhead handling equipment.

As a leading producer of high quality alloy strip steels, mostly of light gauge, the Superior Steel Corp., Carnegie, Pa. has secured definite production advantages and greatly improved overall plant efficiency through abundant use of Cleveland Tramrail cranes.

As the work is primarily that of rolling, annealing, pickling and handling, to obtain maximum production from their equipment, it is necessary to keep it in operation as many minutes out of the day as possible. This means that there be no delays in handling the coils of strip to and from the mills. It also means that the mill rolls must be changed in the least possible time. The Tramrail cranes have proven of great success in fulfilling these requirements and reducing "down time" to a minimum.

They have also proven to be a great aid to the workers' welfare. Being fully motorized, they have practically eliminated all manual lifting and moving. As a result, worker fatigue has been reduced and safety improved.

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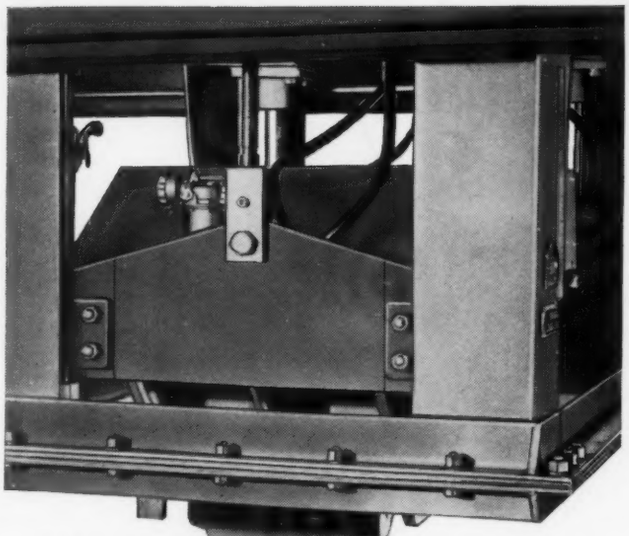
CLEVELAND TRAMRAIL
OVERHEAD MATERIALS HANDLING EQUIPMENT

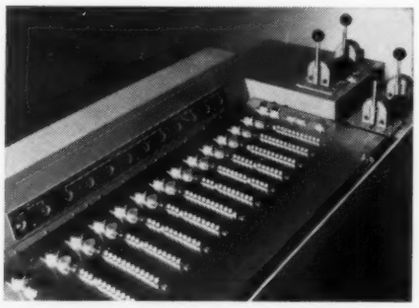


WORLD'S
MOST ADVANCED

Slab AND Bloom Marker

Characters are changed in the marking head and the stamping cycle is actuated from a remotely-positioned operator's console. Among refinements introduced in this latest GY-46 Series: raising and lowering of marking head can clear for 24" bloom . . . keystrips for automatic setup of characters . . . provision for use of printed tapes . . . automatic oiling system . . . provision for setting up by IBM or other punch card system.

On the operator's console a 12-position keystrip may be provided for each of the 12 wheels in the marking head. A press of a button moves any wheel to desired position.



Get comprehensive details in new 4-page Bulletin #613-D-Rev.

Mecco SAFETY Model 701-RCW SLAB MARKER

A Product of the Marking Device Industry

M. E. CUNNINGHAM CO.

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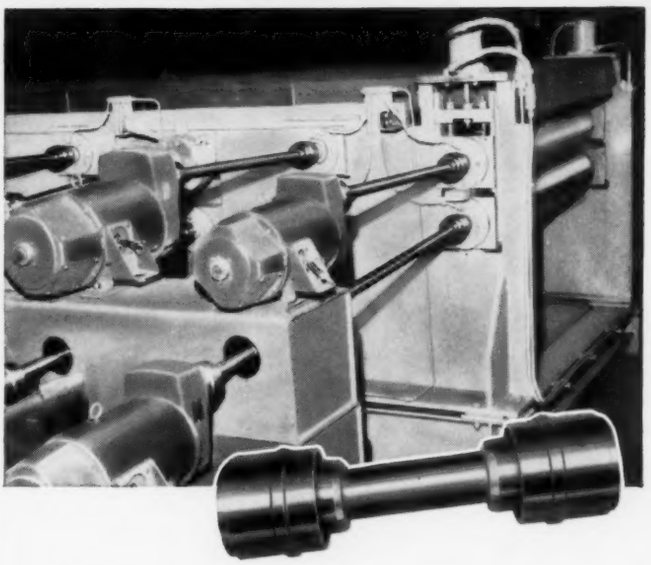

Waldron Ships 67 New Series X Couplings to Major Fabricator for Use on Steel Line

GETS TREMENDOUS INTEREST FROM OTHER STEEL PLANTS

The rugged, new Series X coupling, recently developed by John Waldron for power transmission drives greater than the normal capacity of flexible gear couplings, is gaining wide acceptance by steel companies for use on annealing lines, trimming lines and similar equipment. The Series X can take up to 5° misalignment while transmitting maximum power.

According to H. A. Anderson, sales manager of the John Waldron Power Transmission Division, the new couplings have "created great interest in the steel industry because of their unique design and sturdy construction."

UNIQUE DESIGN

The success of the new coupling is largely dependent on its unique design. The Series X dismantles and assembles quickly. Removing two set screws disengages the sleeves from the hub allowing easy maintenance while keeping downtime to a minimum.

Specially designed seals keep the lubrication in, dirt and moisture out, even at the 5° misalignment capacity. An extremely close fit on the machined surfaces of the Series X rigid hub makes the coupling really solid. The design places the weight of the coupling on the rigid hub surfaces permitting the gear teeth to be used for driving only.

RUGGED CONSTRUCTION

High quality forgings are used for strength in the hubs and sleeves, while shafts cut to customer specifications are made of steel. Nylon plugs in the hubs prevent wear on the roll shaft ends. All parts are machined to extremely close tolerances.

SIZES AND RPM

The new Series X coupling is available in bore sizes from 1¼" to 4½"; they will take from 3½ hp. to 210 hp. per 100 rpm. The couplings transmit smooth, trouble-free power from the driver to the driven units, even under high misalignment conditions.

MFR JOHN **WALDRON** CORPORATION

Subsidiary of Midland-Ross Corporation

NEW BRUNSWICK, NEW JERSEY

precision

Precision is the watchword during every step in the manufacture of Blaw-Knox Rolls. This extra care at every step, maintained by constant close inspection, is your assurance of rolls having the exact properties, dimensions, and finish for maximum service in the stand.

Our rollmakers have more than a century of close association with the metal rolling industry in the development and manufacture of rolls to meet the most rigid service requirements.

Blaw-Knox Roll Engineers welcome the opportunity to join with you in selecting rolls of the proper grade and design for your operations.

BLAW-KNOX COMPANY • Foundry and Mill Machinery Division • 300 Sixth Avenue, Pittsburgh 22, Pennsylvania.

a Bearings, Inc. conversion with a 2 year record of no lost production, reduced maintenance . . . and a 30% Power Savings!

Over two years ago our engineers converted this main drive gear from a babbitt bearing to a ball bearing unit on a machine at Highland Park Manufacturing Company, Charlotte, North Carolina. Performance of this conversion, according to company engineers, has been outstanding! The housing for the bearings as well as the gear hub was produced by the customer in their own machine shop.

Prior to conversion, machine downtime was excessive because the babbitt had to be repoured every three or four months. A plus saving was in the reduction of power required to operate the machine. Highland Park Manufacturing Company officials now find power consumption is 30% less!

If your older equipment can be modernized with anti-friction bearings — our engineers can show you how. If you need bearings for any purpose, our stock carrying branches can supply you. We are *authorized* distributors of most nationally known makes of bearings. We and the makers guarantee every bearing we supply — Call the branch nearest you now!

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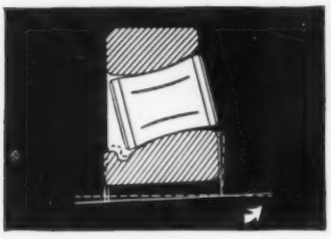
LONGEST LIFE UNDER TOUGHEST CONDITIONS

With Shafer Self-Aligning Roller Bearings your equipment lasts longer under tough conditions that usually spell early trouble.

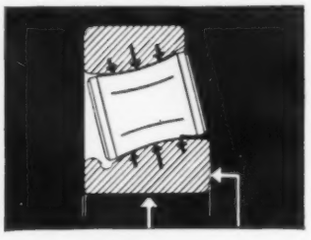
You eliminate many hours of costly down time and keep maintenance costs at a minimum... you get the very best in dependable service.

The reason: Shafer Self-Aligning Roller Bearings maintain their high load-carrying capacity and long life under any type of load. Here's why:



Shaft deflection

Under misalignment due to shaft deflection (a total of 3°), Shafer design allows full freedom of action without extra wear.

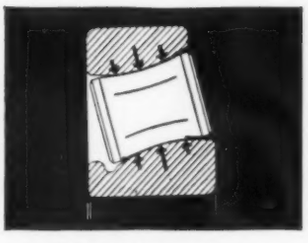


Radial, thrust or combined loads

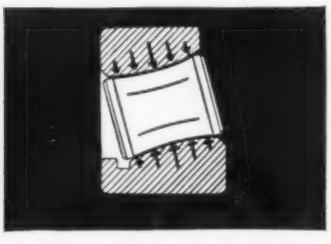
Due to Shafer concave-roller, convex-race design, all loads remain safely centered on tough load-bearing surfaces. Because of self-centering rollers, there's no need for guide flanges at roller ends.

Shock Loads

Shafer design combines the low-rolling friction of a ball with the high load and shock capacity of a roller. The elasticity of Shafer rollers and raceways permits compression under shock. The contact area increases to fit the load-bearing area to the load requirement.



Under Normal Load



Under Heavy Load and Shock

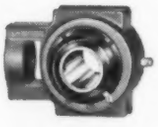
Pillow Blocks

Flange Units

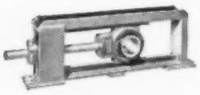
Flange Cartridge Units

Cartridge Units

Duplex Units



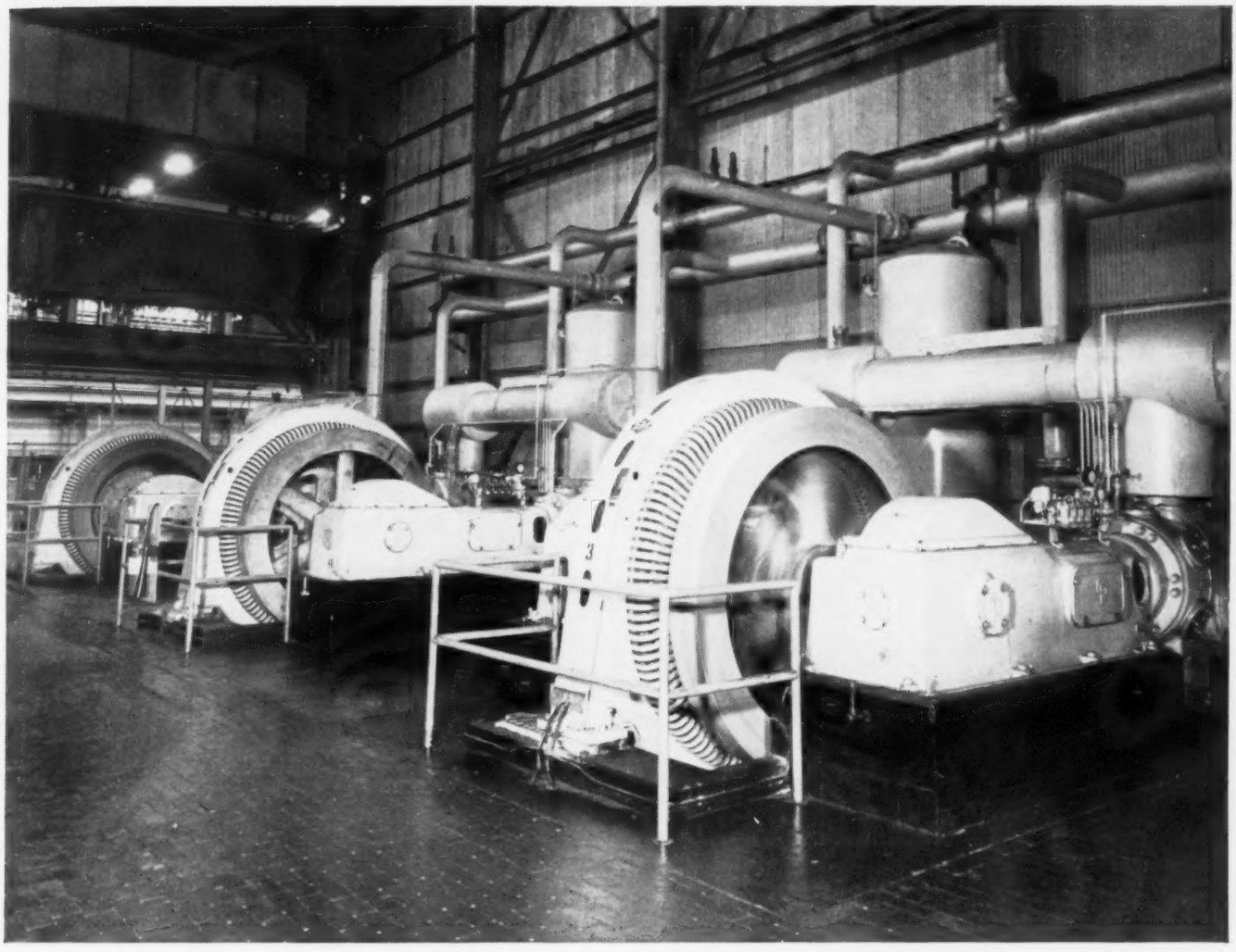
Take-Up Blocks



Take-Ups

SHAFER®
SELF-ALIGNING ROLLER BEARINGS

For complete information on the plus advantages of Shafer Bearings, see your distributor or write for your free copy of Bulletin 59A. CHAIN Belt Company, 4693 W. Greenfield Ave., Milwaukee 1, Wis. In Canada, write CHAIN Belt (Canada) Ltd., 1181 Sheppard Ave., East, Toronto.



Above are three 500 hp, 225 rpm, 2300 volt, 0.8 power factor E-M Synchronous Motors driving air compressors in the tin finishing department at the new Fairless Works of United States Steel Corporation. Three other 500 hp and five 300 hp E-M Motors also drive air compressors, in the hot strip and slab mill, central power station, open hearth pumphouse and sulfate building of the coke works.

Power costs held low on compressor drives at new Fairless Works

Supplying air for controls, tools, handling systems and maintenance equipment is vital business at Fairless Works. And cost of power for operation of the air compressors is an item to be watched in such a large mill.

That's exactly where the E-M Synchronous Motors fit in. They help contribute real economy and rugged reliability to compressor operation.

First of all, these 11 E-M Motors are capable of supplying approximately 2700 reactive kva to improve plant power factor, a significant element when you want to minimize power costs.

Secondly, the inherent high efficiency of E-M Synchronous Motors utilizes power most sparingly.

Other economies are accomplished by use of simple and low-cost full-voltage control for across-the-line starting. Maintenance economy is foretold by simplicity of E-M Synchronous Motor direct-connection . . . by extra strong lashing of E-M stator coils . . . by the high capacity of E-M cage windings to withstand repeated starting stresses.

To get top performance from your large compressor drives, discuss your needs with your nearest E-M sales engineer. And write factory for E-M Synchronizer No. 42, a special issue on the ABC'S of Synchronous Motors.

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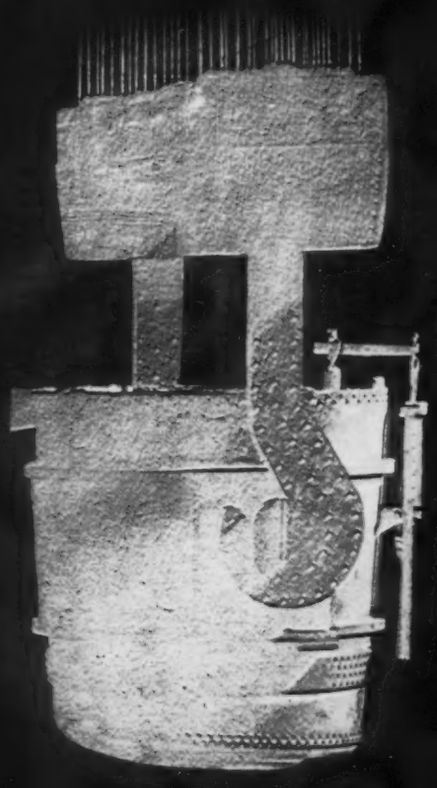

PACECO cranes can set your mind at ease. Rugged–dependable–with simplified maintenance requirements. PACECO cranes speed production and build profits.

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New concepts in crane controls, full anti-friction bearing machinery components, and compact trolley machinery arrangements mean lower first costs and minimum maintenance. PACECO'S 36 years of design and fabrication leadership make PACECO cranes better cranes to meet the rigid demands of mill operation. Put your specifications in the hands of crane craftsmen who minimize cost yet retain quality with superior performance.

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(Continued on page 250)

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BOX 1001, IRON AND STEEL ENGINEER
1010 Empire Building, Pittsburgh 22, Pa.

Equipment News

(*Continued from page 238*)

the K-23 9-in. straight averages 1.85 lb.

Better mortar bonding and resistance to gas erosion are other important features of both the K-20 and the K-23 IFB. Having a clean surface, the brick develop a better bond when layed up in a wall because the mortar holds tightly. Superior resistance to direct flame exposure enables the insulating firebrick to withstand the erosive effects of circulating gases and flame impingement, thus affording long and profitable service in a wide variety of applications.

The firebrick can be tailor-cut, drilled or shaped as necessary, eliminating the need for costly special shapes and the delays involved in obtaining them.

MARKING UNIT

△ Jas. H. Matthews & Co. announces its automatic stamper for steel mill marking of slabs, blooms or billets.

In its marking application, the unit functions when an operator sets the required mark at the remote console selector, actuating an electronic-pneumatic cycle to index character wheels on the stamper corresponding to those selected. These characters appear before the operator in numerical indicator tubes for his inspection and verification of marking set-up. With the stamping head thus prepared, the indexing mechanism is disengaged and the impact thrust to produce the mark begins. When the mark has been made, the stamping head returns to be re-engaged for the next indexing. The remote control electronic console enables the operator to set each of the stamping wheels from a pulpit located at a comfortable distance from the line, and then produce the marking impact at a touch of a control button.

One of the features of the machine is its number indexing mechanism. While the marking unit is at rest position, removed from any danger of heat, the numbers to be stamped are set. The indexing unit remains at this station, however, as the stamping head advances to marking position. Thus, there is no shock to the indexer, because of impact, which could damage its smooth working action.

DELAY IS CANCER'S FRIEND

Cancer needs time to develop. The more time you give it, the less curable it becomes. Of the 255,000 Americans struck down by cancer last year, 75,000 died *needlessly*—enough to populate an entire city the size of Racine, Wisconsin or Santa Monica, California. These patients could have been saved if they had sought diagnosis and treatment in time.

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GUARD YOUR FAMILY—
FIGHT CANCER WITH A
CHECKUP AND A CHECK

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AMERICAN CANCER SOCIETY

INDEX TO ADVERTISERS

OCTOBER, 1959

A

Air Products, Inc. 50
Allen-Bradley Co. 227
Alliance Machine Co. 12, 13
Allied Chemical Corp., Wilputte Coke Oven Div. 156
Allis-Chalmers Manufacturing Co. 43, 45, 47
Aluminum Co. of America 212
American Air Filter Co. 68
American Brakeblok Div., American Brake Shoe Co. 160
American Messer Corp. 30, 31
Appleton Electric Co. 206
Atlas Car & Manufacturing Co. 224

B

Babcock & Wilcox Co., The 168
Bailey Meter Co. 210
Baldwin-Lima-Hamilton Corp., Loewy-Hydropress Div. 155
Bearings, Inc. 243
Berry Bearing Co. 181
Bethlehem Steel Co. 159
Birdsboro Steel Foundry & Machine Co. 162
Blaw-Knox Co., Aetna-Standard Div. 1
Blaw-Knox Co., Foundry & Mill Machinery Div. 219, 242
Bliss Co., E. W. 69
Bloom Engineering Co. 238
Bristol Co. 58
Browning & Co., Inc., Victor R. 208
Bussmann Manufacturing Div., McGraw-Edison Co. 214, 215

C

Chain Belt Co. 244
Chemical Construction Corp. 187
Cities Service Oil Co. 218
Clark Controller Co. 5, 191
Cleveland Crane and Engineering Co. 10
Cleveland Tramrail Div., Cleveland Crane and Engineering Co. 240
Columbus McKinnon Chain Corp. 176
Cone-Drive Gears Div., Michigan Tool Co. 177
Cunningham, Co., M. E. 241
Cutler-Hammer, Inc. Cover 2, 29

D

Dodge Manufacturing Corp. 220
Dowell 44
Dravo Corp. 60, 176
Drever Co. 213
Duraloy Co., The 180

E

Easton Car & Construction Co. 234
Electric Controller & Manufacturing Co., Square D Co. 193
Electric Furnace Co., The 235
Electric Machinery Mfg. Co. 245
Electro Alloys Div., American Brake Shoe Co. 20
Elwell-Parker Electric Co. 184
Euclid Electric & Mfg. Co., The 173

F

Farval Corp., The Cover 3
Feller Engineering Co. 4
Flaktfabriken, Svenska AB 63

G

General Electric Co. 70, 71
General Steel Castings Corp., National Roll & Foundry Div. 237
Golden-Anderson Valve Specialty Co. 233
Great Lakes Carbon Corp. 32
Green Fuel Economizer Co., Inc. 211

H

Hauck Manufacturing Co. 236
Hill Acme Co., Cleveland Knife Div. 176
Hunt Valve Co. 46
Hyde Park Foundry & Machine Co. 226

J

Jeffrey Manufacturing Co., The 186
Johns-Manville Corp. 161, 225

K

Kaiser Engineers 192
Kinney Engineers, Inc., S. P. 202
Koppers Co., Inc. 14, 15, 232

L

Larco, Inc. 202
Lectromelt Furnace Div., McGraw-Edison Co. 74
Leeds and Northrup Co. 166
Lewis Machine Co., The 188, 189
Linde Co. Div. of Union Carbide Corp. 59
Link-Belt Co. 197
Loewy-Hydropress Div., Baldwin-Lima-Hamilton Corp. 155
Lombard Corp., The 28

M

Mackintosh-Hemphill Div., E. W. Bliss Co. 2
Manning, Maxwell & Moore, Inc. 207
Mansaver Industries, Inc. 173
Messer Cutting Machines, Inc. 199
Mesta Machine Co. Cover 1, 194
Midvale-Heppenstall Co. 247
Minneapolis-Honeywell 216, 217
Morgan Construction Co. 230, 231
Murray Mfg. Co., D. J. 221

N

National Bearing Div., American Brake Shoe Co. 174, 175
National Carbon Co., Div. of Union Carbide Corp. 35, 36, 37, 38, 39, 40, 41, 42, 200
National Electric Coil Div., McGraw-Edison Co. 229
National Roll & Foundry Div., General Steel Castings Corp. 237
North American Manufacturing Co. 182

O

Ohio Steel Foundry Co., The 178

P

Pacific Coast Engineering Co. 246
Pangborn Corp. 185
Pennsylvania Engineering Corp. 26
Poole Foundry and Machine Co. 252
Post-Glover Electric Co. 65

R

Ramtite Co. 55
Refractory & Insulation Corp. 183
Reliance Electric & Engineering Co. 51, 52, 53, 54
Rockwell Co., W. S. 234
Rust Furnace Co. 153
Rust-Oleum Corp. 56, 57

S

Sack, Maschinenfabrik G.m.b.H. 64
Salem-Brosius, Inc. 34
Selas Corp. of America 66, 67
SKF Industries, Inc. 33
Socony-Mobil Oil Co., Inc. 48, 49
Spraying Systems Co. 221
Stamco, Inc. 202
Steel Equipment Co. 203
Surface Combustion Corp. 72, 73
Swindell-Dressler Corp. 204, 205

T

Taylor Chain Co., S. G. 226
Taylor Instrument Cos. 8, 9
Texaco, Inc. Cover 4
Timken Roller Bearing Co. 19
Titzel Engineering, Inc. 228
Torrington Co., The 25
Trabon Engineering Corp. 222

U

Union Carbide Corp., Linde Co. 59
Union Carbide Corp., National Carbon Co. 35, 36, 37, 38, 39, 40, 41, 42, 200
Union Carbide Metals Co., Div. of Union Carbide Corp. 165
United Engineering & Foundry Co. 17

W

Wagner Electric Corp. 171, 172
Waldron Corp., John 241
Wean Engineering Co., Inc. 209
Western Precipitation Corp. 18
Wheelabrator Corp. 16
Whiting Corp. 190
Wilson Engineering Co., Inc., Lee 7

Y

Yoder Co. 6
Youngstown Alloy Casting Corp. 239
Youngstown Welding & Engineering Co. 23

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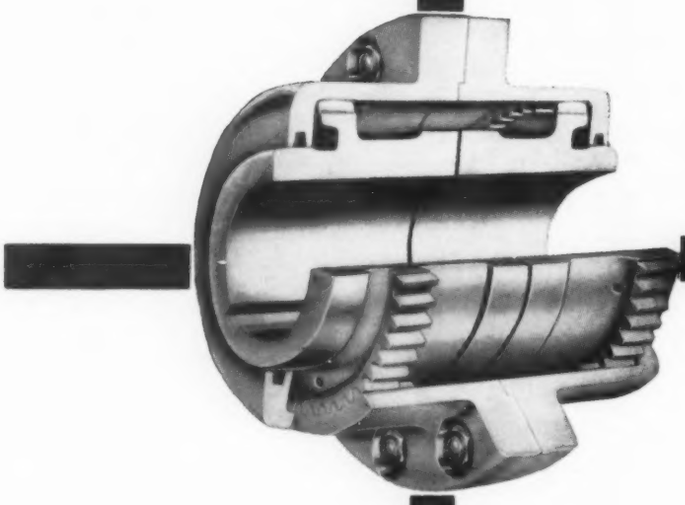

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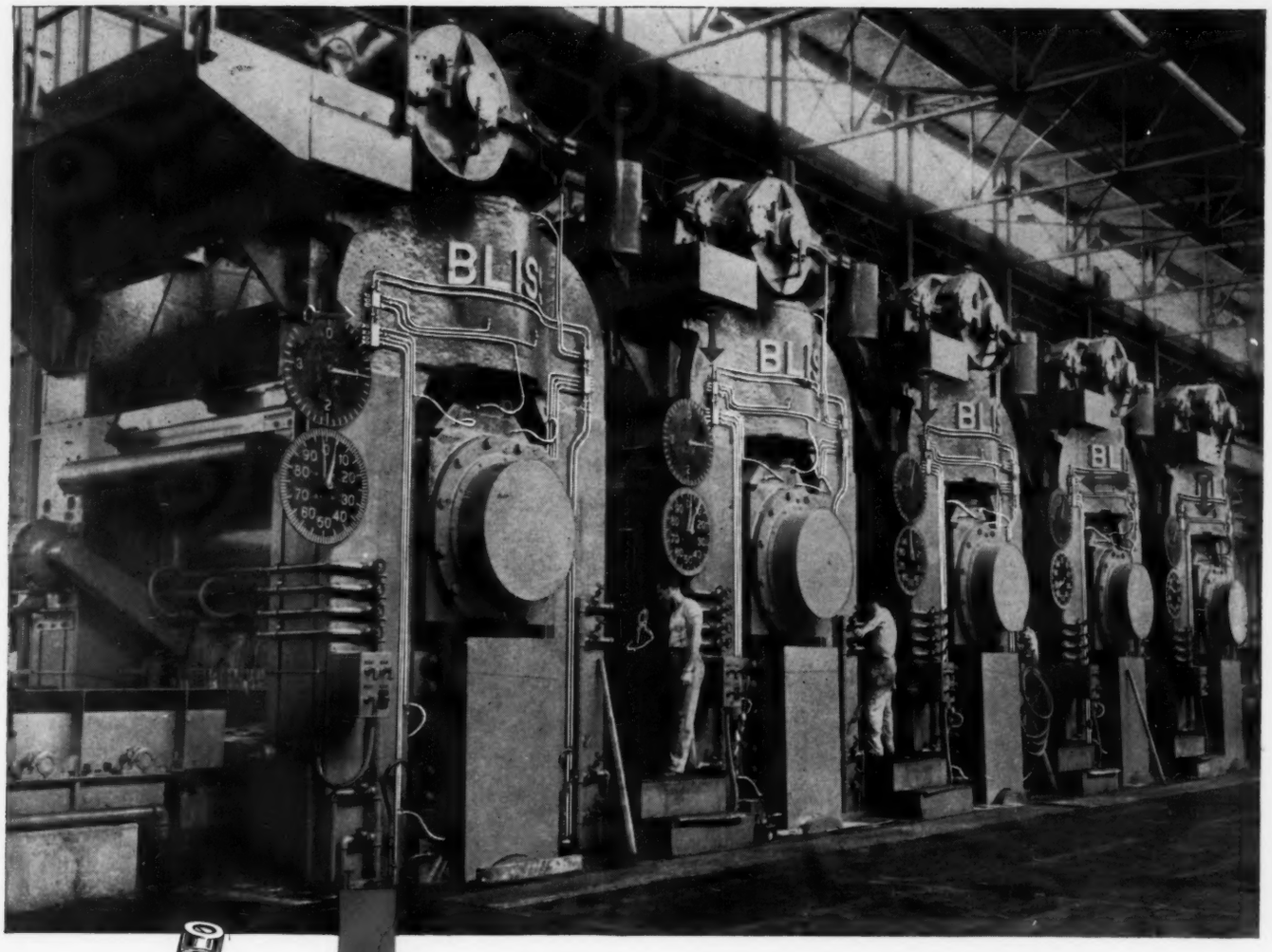

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—Studies in
Centralized
Lubrication
No. 244

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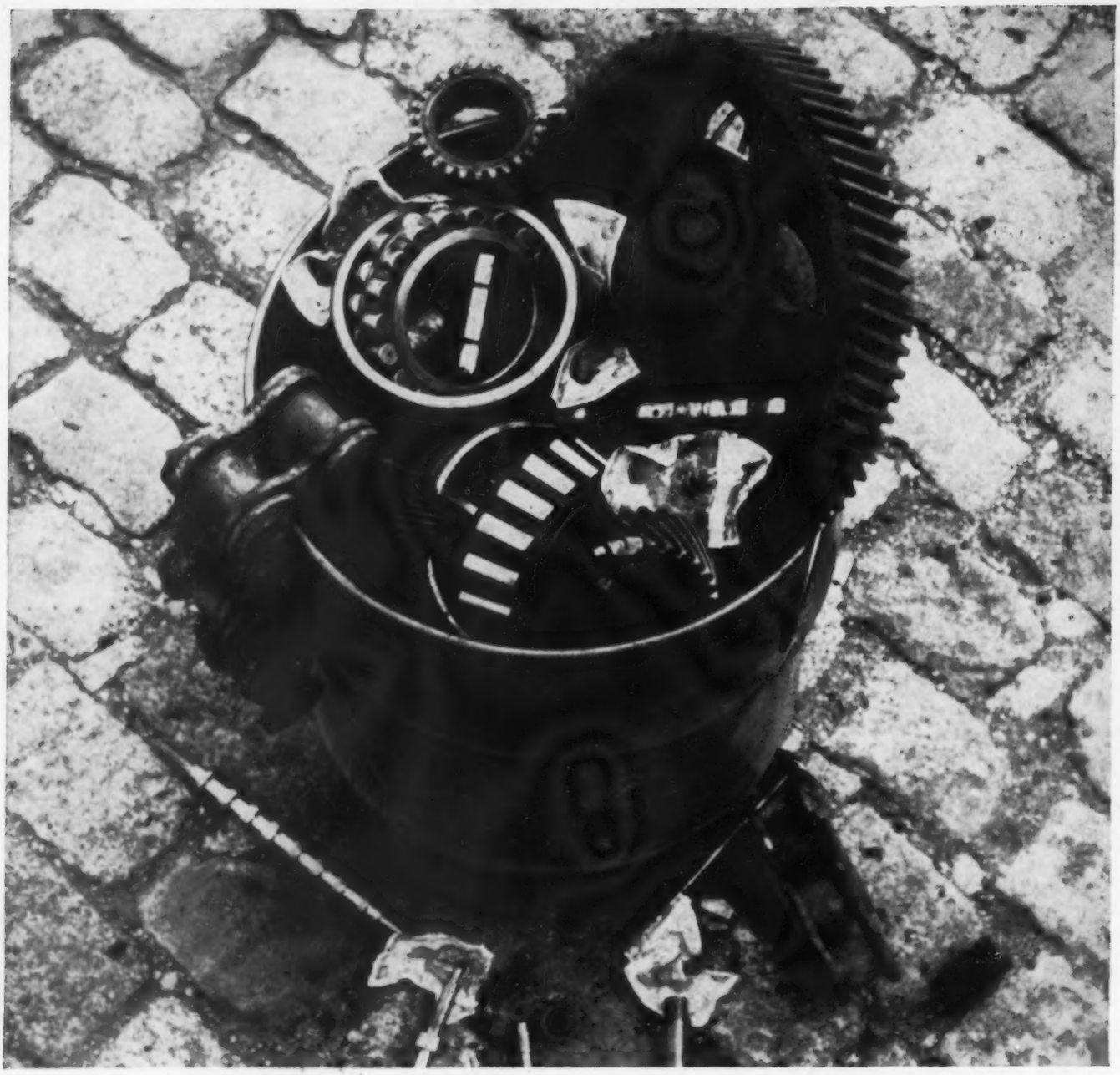

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